COLLEGE OF ENG

the Cornell

University Microfilms
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NOVEMBER, 1955

VOL. 21, NO. 2

25 CENTS

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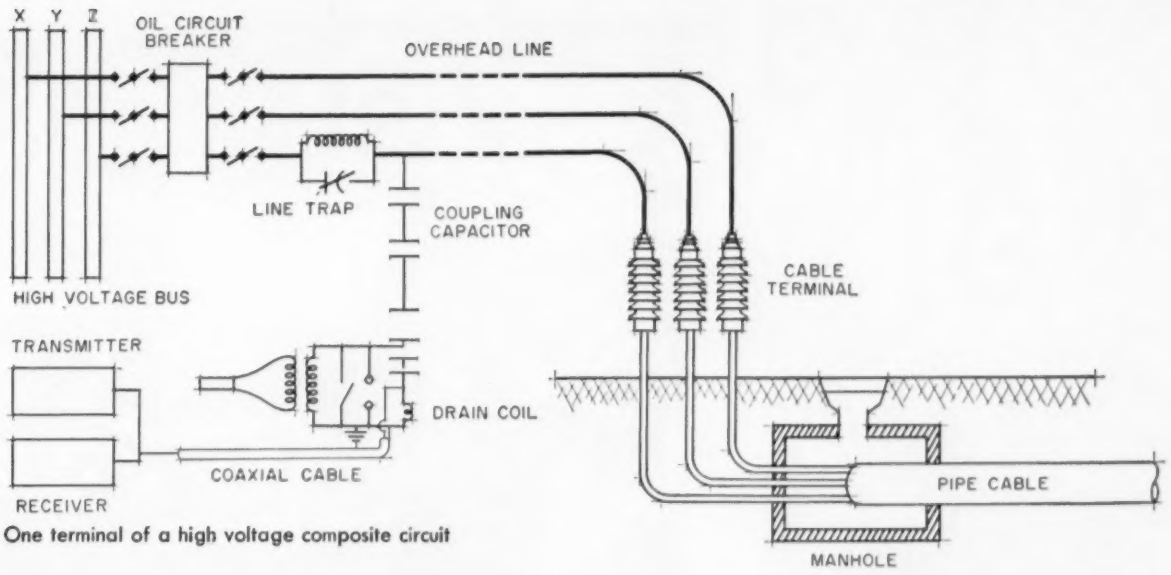

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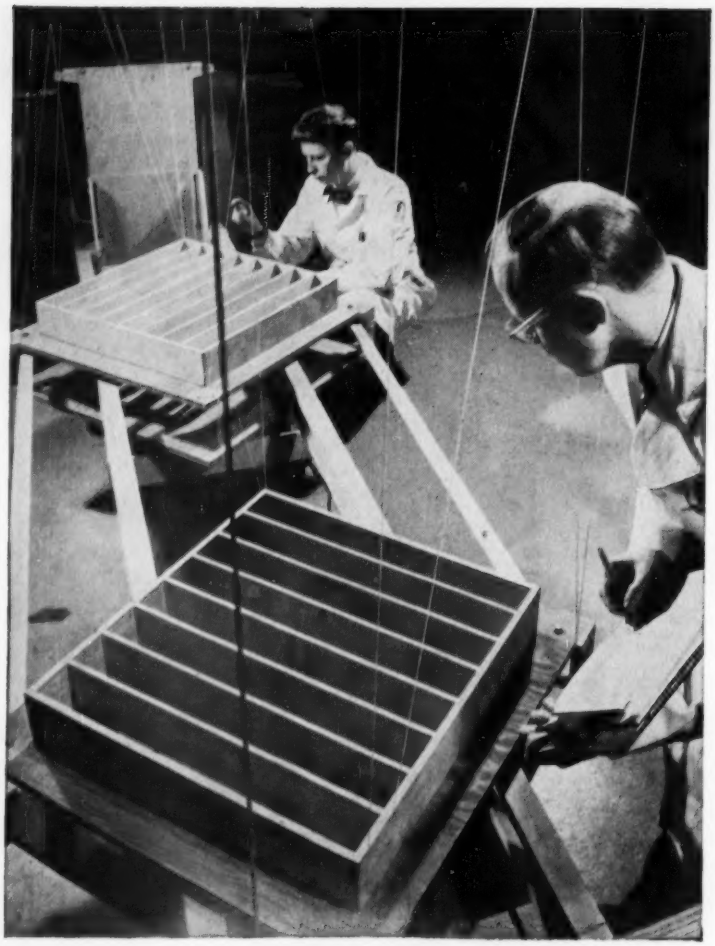

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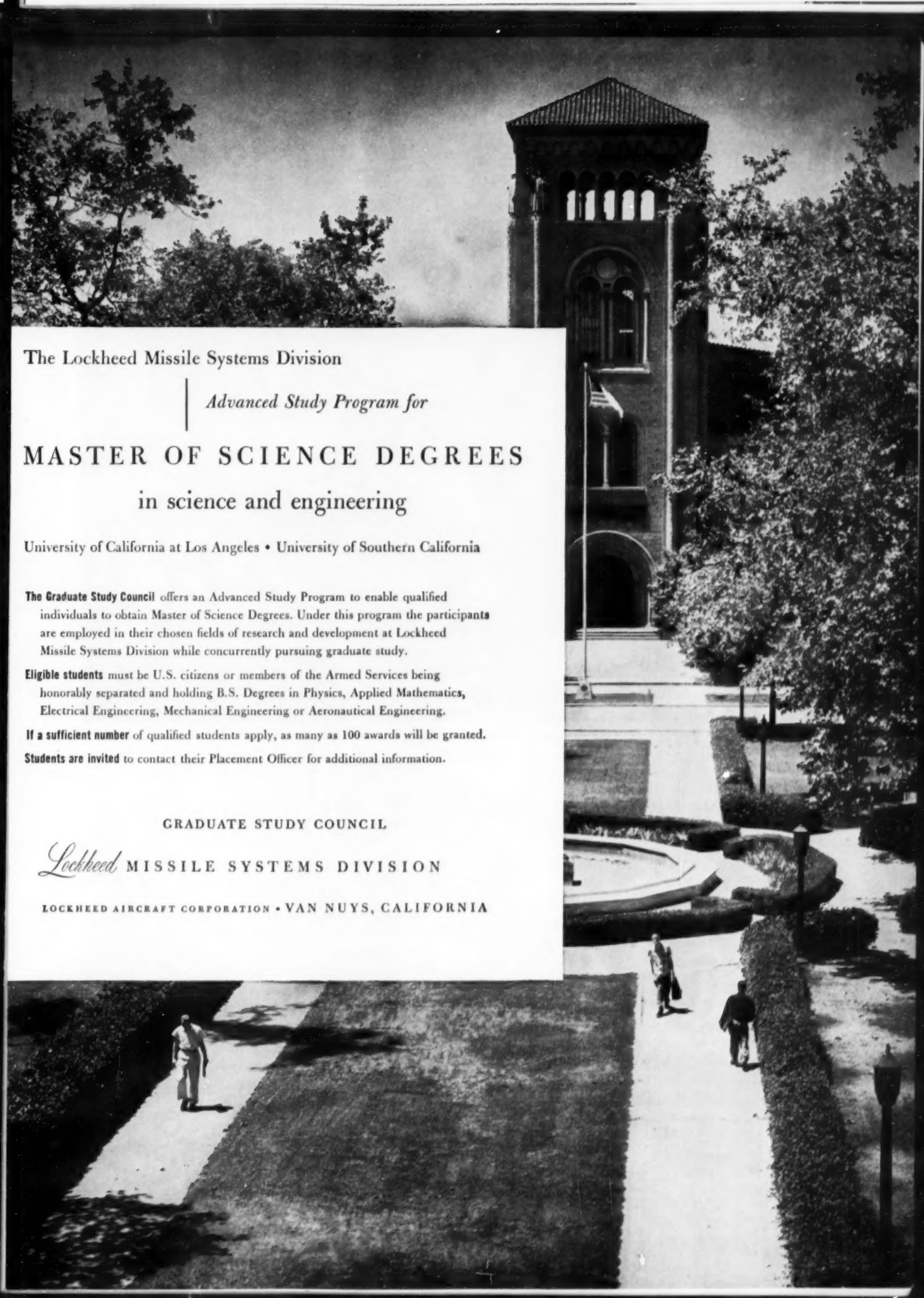

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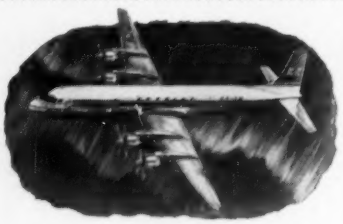

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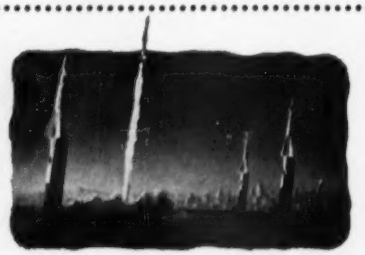

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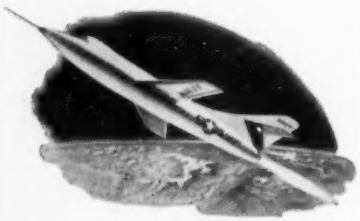

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Editorial

At present the Engineering Student Council is considering the problem of trying to interest all the Engineering Schools at Cornell into adopting the "honor system," responsible for his own academic integrity. Under the present system used in the School of Civil Engineering the student is on his honor to do his own work. The Civil Engineers are morally bound to report any offenders, and they staff their own committees who judge and try each offense.

The question of whether or not the honor system will be adopted lies not only to the students themselves who must show a desire for such a program but also to the faculty. The lead, however, must be taken by the undergraduates for it is us and not the faculty who will benefit from the experience of having the "honor system" as part of our academic careers. Not until the students, ourselves, realize that we want the "honor system" can this program be achieved.

The present outlook upon the problem is one of indifference; I don't believe that many even realize that one exists; most take for granted that an exam, when given, will be proctored and that cheating is not cheating until one is caught. This belief, however, is not true, for if this idea is allowed to persist through an engineering profession as in any profession, the safety of many people who may depend on your work may be endangered not to mention the millions of dollars of capital which might also be wasted. Although these ideas in themselves are not new to the arguments for the "honor system" it does not mean that they are not still valid.

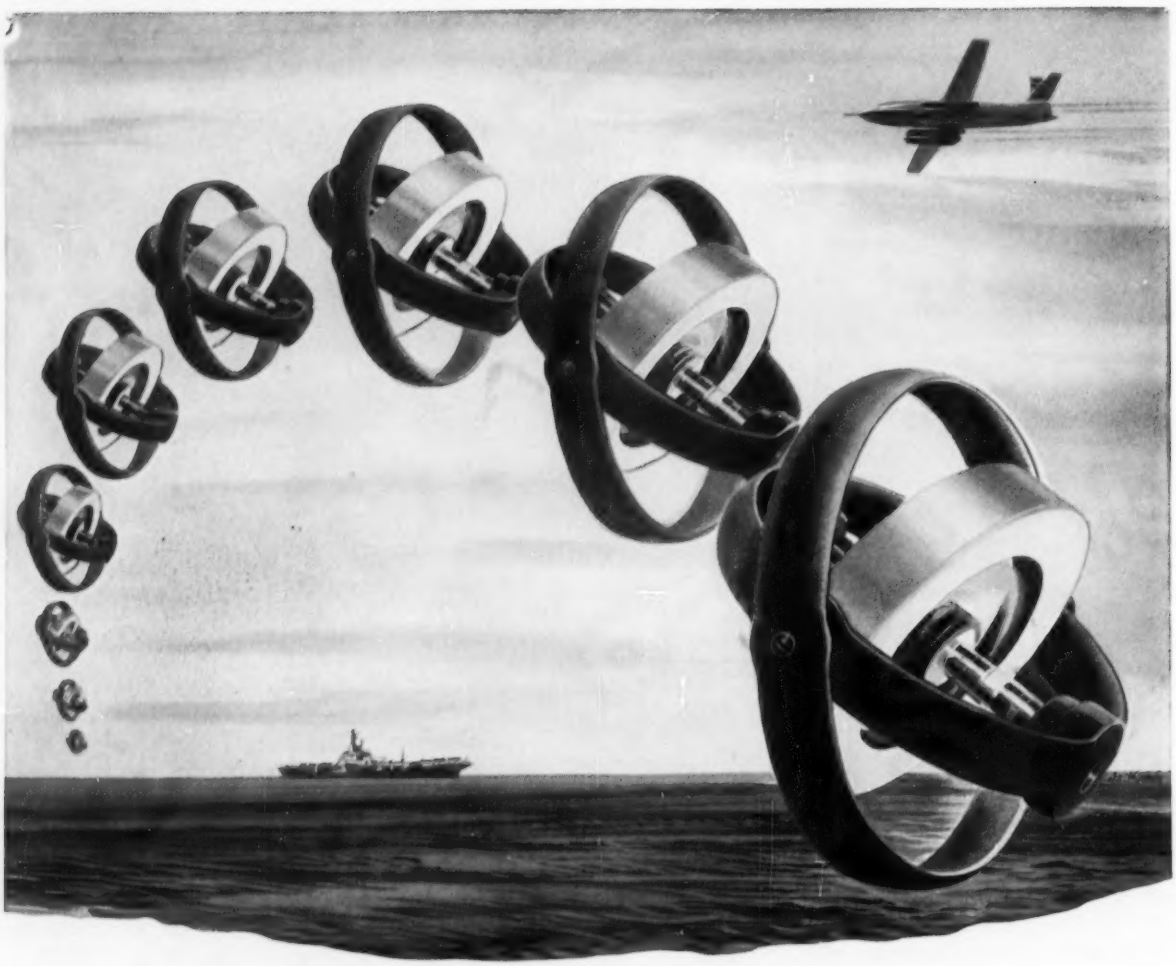
We can see that the "honor system" is workable by the results which have been achieved in the School of Civil Engineering. To evidence these results is the fact that examinations in the Civil Engineering School are given unproctored, resulting in a better use of the instructor's time and the creation of a more "at ease" feeling in the student. It might also be said that the development of the "honor system" has increased the "esprit de corps" of the civil engineer in knowing that he belongs to a unique group. These points, however, are only minor compared to the real product that of having developed a character building medium.

To plan such a program for the entire College would of course be very difficult, for the transition, if too sudden, might be too much of a change for everyone to except. Therefore, my idea on the subject is that instead of changing our entire outlook of the matter over night, we might try to begin with a slow and gradual change beginning the movement at recitation or course level in just the upperclasses, and slowly move downward into the realm of the Sophomore and Freshman classes. The reasons why I believe that this may be the solution is that Seniors and Juniors, now because of age and experience would more readily realize the value of having the "honor system." It is also obvious that due to the size and mechanical nature of instruction now being used in many lower class courses that the "honor system" might only be accepted as an easy way to get something for nothing.

I will leave this discussion with a final re-emphasis upon the fact that we, the students, must decide upon the question for it will be us, if and when such a plan is adopted, who will carry the responsibility for its success. If you want to accept the responsibility then you must be ready to answer affirmatively the following questions. Would you, under the "honor system," report a friend for cheating? Would you be willing to contribute active support to the honor committees which would be established? The success of the "honor system" depends upon the group attitude toward these two questions.

In an attempt to draw student feelings on this very controversial subject THE CORNELL ENGINEER would appreciate receiving letters from the readers on their interest in this question of whether or not the "honor system" should be adopted.

—B.D.G.



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THE CORNELL engineer

NOVEMBER, 1955 VOL. 21 NO. 2

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It is a simple matter for a potential airlines passenger to pick up his telephone and make reservations for a cross-country flght. A average of 32,000 such calle occur daily, for one airlines company. But for the company, this involves a monumental pob of clerical work, and fast communications, and record-keeping; But the job can now be handled electronically, by a system of devices recently installed by United Air Lines, and soon to be adopted by a number of others.

by Richard Brandenburg, ME '58

INDUCTIVE COORDINATION 16

Designers of modern communication and electric power sytems are faced unavoidably with problems arising from inductive effects of the power systems upon selephone systems in cloes proximity. The coordinated design of the two systems, to minimize the problem, is termed Inductive Coordination, now becoming na important topic.

by John F. Ahearne, EP '57

THE TREND TO PREFABRICATED HOUSING 19

The number of firms engaged in manufacturing and selling prefabricated homes was increased from one (Sears-Roebuck) in 1900 to about 30 in 1939; none, by that time, had achieved commercial success. Last year more than 77,000 prefabs were sold, representing about 7% of all new single-family dwelings of 1954.

by Leonard Pisnoy, CE '57

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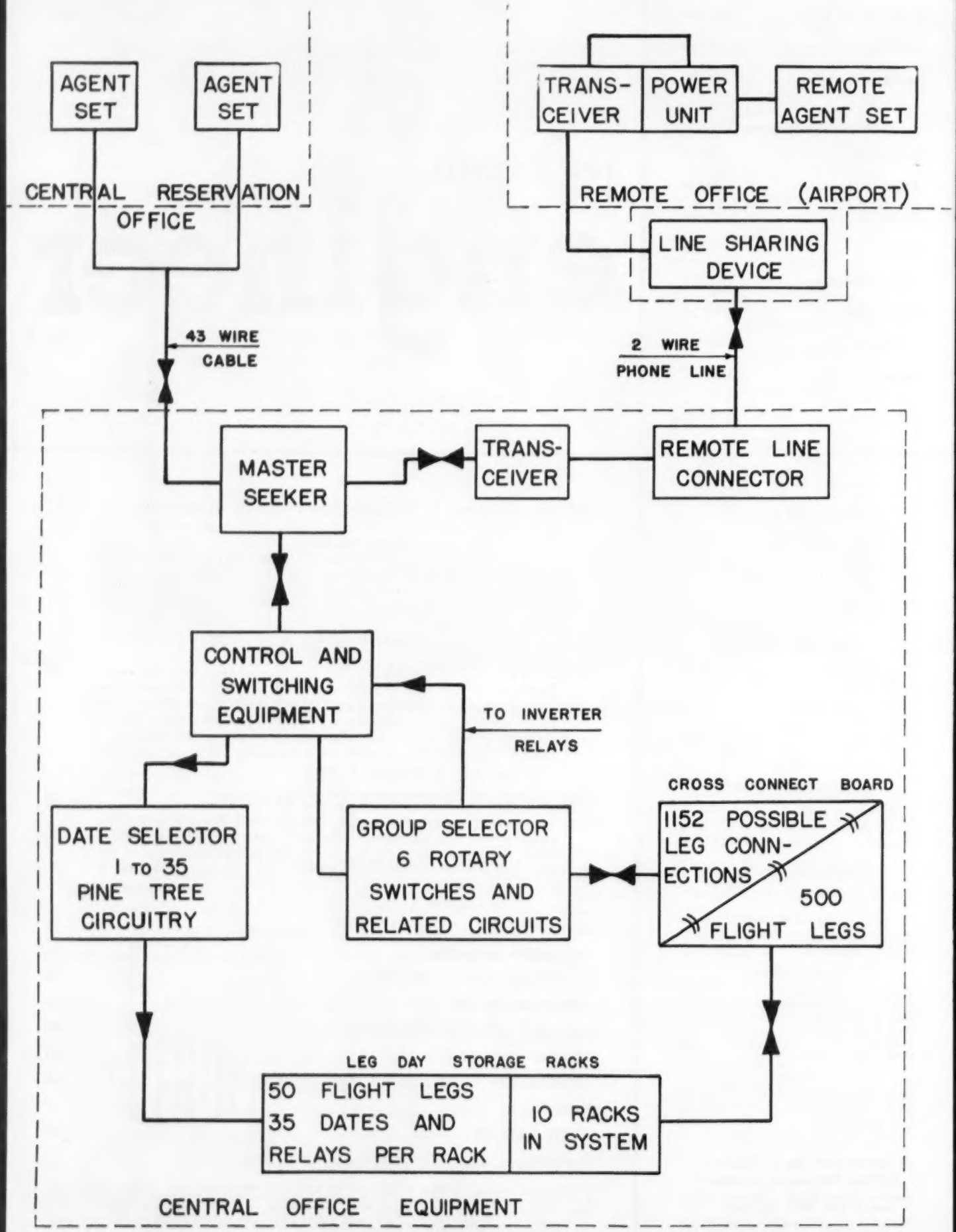
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10 RACKS IN SYSTEM
CENTRAL OFFICE EQUIPMENT

UNISEL

An Answer to Airline Reservations Complexity

by RICHARD BRANDENBURG, ME '58

(Illustrations by courtesy United Air Lines)

Fast growing commercial air transportation poses the challenge of constant improvement in the daily handling of passenger reservations. By the end of 1955, domestic scheduled airlines will have earned a record billion dollars in revenue. Major airlines, encountering procedural problems along with financial success, need better sales and records methods to give personal customer service on a large scale basis. The Reservisor System, manufactured by the Teleregister Corporation of Stamford, Connecticut, is an electro-mechanical answer to the need for prompt space availability information on the many flights operated by large airlines.

United Air Lines, one of the nation's "big four" carriers, has installed a pioneering Reservisor System called "Unisel." United, averaging about 18,000 passengers daily during the summer of 1955, has experienced a three fold increase in passengers carried annually over the number carried ten years ago. An average 32,000 phone calls are received daily from customers desiring reservations.

The impact of Unisel in meeting the challenge of increased reservations requests is summed up by H. J. Merchant, United Air Lines' Assistant General Manager of Sales:

"For some time there has been growing disparity between the speed and efficiency of airline operations overhead and certain clerical procedures on the ground. Our progress in the air has brought the 365-mile-an-hour DC-7 Mainliner which flies nonstop from coast to coast in less than eight hours. Meanwhile, horse-and-buggy methods have lingered on in handling various phases of passenger reservations and ticketing. This disparity has ended with the introduction of Unisel, which supplants hand methods with electronic speeds. Combined with other automatic devices, Unisel provides the fastest, simplest and most effective ticket sales and reservations set-up in transportation history. Our clerical procedures have caught up with the fastest aircraft and we are ready for the Jet Age ahead."

Block Diagram of Reservoir System Major Components.

Agent Set Starts Data Selection

Transforming the simple action of pressing two buttons, inserting a metal plate in a slot, and throwing a switch, to space availability information for a given date on an airplane flight is the function of the Reservisor System. The airplane's potential passenger phoning for reservations obtains instant information from the sales agent, or if buying his ticket over the counter, sees only a small metal device like an adding machine. The adding machine like mechanism is the agent-passenger end of Reservisor. Its simple array of numbered keys for dates, lights for indicating error and information validity, switches for "availability" and "check" operations, and an opening to receive a metal plate is the beginning and end of a complex chain of electro-mechanical functions that makes air travel easier for both airline and passenger.

The sequence for determining whether a seat is available between two cities served by a given flight on the desired date reveals the operation of Unisel. The sales agent, who may be one of many handling calls in one of United's four major reservations offices in a large city, or who may be on duty at a ticket counter in a hotel or at an airport, has a set of small metal plates that trigger specific flight selection. Each plate has a printed card on both sides. These cards are divided into four horizontal rows, one of the adjacent groups of two being up-side-down in relation to the other. In this way, the agent can properly read only two horizontal rows at one time. Each of these rows is divided into 8 boxes, in which are printed flight number, departure time, and city of origination and termination of the flight. In a given row, flights serving the same two cities are grouped conveniently so that a passenger may be offered alternate times of departure on the same day if one flight is filled.

The top and bottom edge of each plate is cut in an arrangement of metal teeth that form the first step in establishing a coding to ultimately select desired data on eight of the hundreds of flights recorded in Unisel. The teeth trigger combinations of ten switches in the agent set that start the data selection operation. A shutter on the agent

Fig. 1. Main office personnel store space availability information in leg day storage racks by inserting ground-causing plugs that control agent-set query response of light or no light.

set provides the next coding step. The shutter is arranged such that only one of the two rows on a plate that can be properly read at a time is visible. The agent can flip the shutter to block out the row of flights not desired. Actuating the shutter operates a switch further contributing to a unique even combination of acro switches that filters out all but the desired group of eight flights for agent use.

To complete coding before Unisel's main equipment goes to work, the agent presses numbered keys on his set to indicate the date on which seat availability is desired on the eight flight group selected. Two rows of date keys, one each for the tens and units places, are provided. Single digit dates must be set as "01, 02, 03," etc., so that two keys are pressed for each date. If a mistake is made a red error light flashes on the agent set, warning the operator to try his coding again. Proper operation brings up a green "check" light on the set. Thus the two simple actions of depressing the proper date keys and inserting the destination plate with the desired flight legs listed on it are ready to be transformed into data selection processes in the main equipment.

By throwing a lever switch on the agent set to "available" position, the sales agent completes his role in the function of Unisel. The machine now takes over until the query is completed. Each precoded agent set must in turn take over the control and switching equipment to obtain flight information. Since only one agent set at a time can call for data, a master seeker rotary switch cuts individual sets into the main facilities. Putting the key in "available" position calls for the master seeker, the wipers of which will step around to connect agent sets to the control equipment in the order of their requests. In normal operation this selective channeling of requests and answers takes place in a fraction of a second. Each agent set ties up the equipment for only .6 seconds before it is disconnected from the central mechanism. Information may then be held on each agent set as long as needed, because sets are individually electrified.

Rotary Switches Select Flight Group

When an agent set has control of the main facilities, its coded question is divided into two parts—the group of eight flights desired, and the date on which the flights are to be checked for space. A distinct flight group has been coded by an even combination of ten acro switches and the shutter switch in the agent set. These switches filter through a large agent set connect relay actuated by the master seeker. The acro switches can now operate associated relays in the control equipment that are a part of a complex "pine tree" circuit. This pine tree relay combination consists of two basic circuits, one selecting one of six main rotary switches in the group selection part of the equipment, and the other marking a specific rotary switch level.

Each of the six main rotary switches involved in group selection has a bank of 24 stationary levels of nine contacts each, and a set of rotating wipers that connect with a single level. These rotarys filter out data on a particular eight flight group. One of eight of the nine contacts on each level of a given rotary is for each flight in a given group. The ninth contact is triggered by agent set acro switches and related control equipment relays to stop the switch at that level. When one of the six switches selected by the agent set coding is set in rotation, it will continue until it picks up ground from the ninth contact on one of its twenty four stationary levels. The ground cuts off a power supply stopping the rotary in question. Thus, on one of six rotarys, wipers have stopped at one of twenty four levels. One flight group out of a possible 144 has been pinpointed. Eight flights are slated for corresponding availability information.

Relays Pinpoint Desired Date

Finding out if seats are available on the desired date is the second major function of the central equipment. Another pine tree combination of relays begins to function, triggered by the date key switches on the agent set. Each date key depressed operates two date selection relays that are connected through additional pine tree circuitry to ultimately operate a date relay in each of the ten leg day storage racks. The racks, occupying wall space on two sides on a large room, each have 1750 jacks, into which a United Air Lines employee inserts plugs to represent no space available, or that space on a given flight is almost sold out. Each jack is wired into the equipment such that a plug inserted in it provides a ground from the jack that eventually reaches the agent set. The large racks are numbered across the top by date from 1 through 35, so that each vertical row of fifty jacks corresponds to a single date.

Flights are listed down the left side of each board, and are divided into segments according to the cities they serve. For instance, a single flight may stop at Omaha on route to Los Angeles from Chicago. Then each part of the flight, ie. Chicago to Omaha, Omaha to Los Angeles, is listed and has a corresponding horizontal row running across the rack. United's entire flight operations are thus set out on seven of the ten large racks, with a jack opening for each flight segment for each date from 1 to 35.

Plugs Indicate Flight Status

The type of plastic plug inserted in the board governs the ground or no ground response obtained for a given flight on a given date when the flight is one of the eight in the group to be investigated. A switch, at the top and bottom of each jack, is closed as a plug is inserted providing a ground when the jack is queried through date selection relay combinations. A yellow plastic plug is shaped such that its insertion depresses the switch level to make

contact at the bottom of the jack. A red plug is shaped to give top-of-jack contact. No plug means no switch is closed, and no ground is established.

When the United Air Lines employee operating the racks receives a message from United's payload control center in Denver, Colorado, that seat sales for a given day on a flight are to be stopped, he inserts a red plug in the rack at the jack corresponding to the date and flight segment in question. To avoid overselling due to delay in receiving this stop sales message, the airline lets its sales personnel know when a flight is nearly filled. When only a few seats are left, a yellow plug is inserted in the rack. When seats are available for sale no plug is present. Thus the racks picture the condition of all flights, and are ready to be tapped by the sales agent for instant completion of a transaction with a customer.

Individual relays for each date represented on each rack trigger the process of picking desired information off the racks. When a date is selected, pine tree relay circuits fire date relays in each rack for that date. For instance, if the sales agent selects date 25, ten 25 relays function. These relays have a pair of contacts for each flight segment jack under that date. Thus there are fifty contact pairs on each relay that, when electrified, pick up information in the form of ground or no ground depending upon whether or not plastic plugs are in jacks. All date relays in a given rack have their contacts wired together in jumper fashion. This means that fifty wires coming into each rack are sufficient to pick up the fifty pieces of information fed in only by the relay representing the selected date.

Fifty wires from each of ten leg day storage racks return 500 pieces of information to the rest of Unisel's equipment. These 500 pieces of information must now be treated so that data on the proper eight flights only is sent. To accomplish the filtering process, Unisel uses two cross connected demountable wired boards linking storage racks with the rotary switch stationary levels corresponding to flight groups. Five hundred wires from the racks are connected in groups of eight to the twenty four levels on each of six rotary switches. The switch capacity provides for 1152 connections. (8x24x6) The number of connections is reduced to 500 because some flights appear on more than one destination plate due to classification preferences. Thus a trip between two cities may appear on two or more plates, and therefore requires that it be represented on more than one of the 144 eight group rotary switch levels. Thus two or more wires from a contact on a switch level may be a single one of the 500 wires from the storage racks. Seat availability information on eight flights for a single date has now been filtered out by the machine. The proper rotary switch, and proper level on that switch have been connected into the storage racks to call for information on the flight group it represents. At the same time the desired date has been selected, calling from the racks only space information for that day.

The wiper or movable side of the pre-selected rotary switch, resting on the eight contact level for the selected flight group, is now ready to pick up the information for final transmission to the agent set. Each of the six rotarys has two associated relays that operate only when that rotary is selected through destination plate coding. These relays preclude the operation of any other group selection rotary. In addition they cut in the wipers of the selected rotary to eight inverter relays. These trigger each light in a row of eight appearing under the flight labels visible on the destination plate in the agent set.

Inverter Relays Control "Check" Available Response

The inverter relays are so named because their function, when the agent throws his lever to "available," is opposite to that when he puts the lever in "check" position. The "available" position electrifies both upper and lower contacts in the storage rack jacks selected. Thus, if either a red plug has been inserted to indicate no space available, or a yellow plug to indicate limited availability, a ground will be received at the inverter relay. This ground will close the relay, *breaking* a circuit to its corresponding agent set light. No light will appear under the flight label. The agent then knows immediately that seats are available for sale.

The inverter relays provide a different response when the agent throws his lever to "check" to further ascertain the status of the

Fig. 2. Agent set enables instant availability data to be relayed by sales agent to customer. Destination plate, shutter, date keys, and "error" and "check" lights are shown. Agent is operating "check"-"available" lever.

flight for the desired day. On check, a main check relay is closed, and only the bottom contact in each jack is electrified. Thus a ground is fed ultimately to the inverter relay only if a yellow plug, indicating limited availability, has been inserted. But now, due to the operation of the main check relay, circuits to lights are *completed* only when inverter relays operate. The eight inverters no longer act as circuit breakers, but rather, by means of their connection through the check relay, act as switches causing a light to come up under a given flight if a ground-causing yellow plug is present.

The check switch position and corresponding check relay response cuts in the lights in a pulsing ground circuit. The lights are wired through a relay connected in parallel with a resistor-capacitor combination. Initially, the relay closes, lighting a lamp if a ground is present. But after a charge has built up on the RC combination, the current finds less resistance through this alternate path, the relay ceases to function, and the lamp goes out. The cycle then repeats, the resistor and capacitor introducing a time constant for circuit function that causes a flashing light to occur.

Remote Stations Use Phone Lines

Remote stations enhance the versatility of the Reservisor system operated by United Air Lines. Agent sets, located at the airport counter and ticket offices in loop hotels, are linked to the main Unisel equipment by two phone wires. This hookup, utilizing transceivers at each remote station, eliminates the high cost of laying 43 conductor cables long distances throughout the city. One of the two phone lines carrys a 20 cycle pulse that synchronizes a central office rotary switch with one in the remote equipment through the transmitter-receiver combination. When a remote set makes a query, this twenty cycle pulse keeps the two switches stopping together. The second line electrifies or does not electrify the rotating part of the remote rotary depending on the destination plate and date coding. These pulses are fed to the central office rotary wipers, and then to storage relays that are connected to the rotary stators.

The storage relays hold data to be fed into the switching and control equipment that obtains information in exactly the same way as do office sets. Information for the desired flight group and date is fed through the eight inverter relays to eight other storage relays, distinct from those first holding he incoming query. Now the central office transceiver and remote transciver exchange roles, the central office equipment sending pulses, and the remote set receiving them. The two lines carrying pulses bring the data to the relays in the agent set, and lights or no lights come up in the sequence of the received signals from the central office equipment. A line sharing adapter enables a number of agent sets to function at a remote point through one two-wire connection to the main office.

For more reliable operation, dual components, and accurate error detection features are built into Unisel. Most of the main equipment and relays are wired in duplicate in order that a malfunctioning unit can be replaced with its alternate, thereby avoiding a long shut down. A monitor panel on the central equipment indicates visually which agent set is in operation, how many calls have been taken by the equipment, and the total queries from remote stations. A fuse alarm circuit, incorporating 1/3 amp fuses for each agent set, gives both an audible buzzer and a flashing light warning in case of operational difficulty. The only electronic tube in the equipment, of the gas-filled type, acts as a time-out error indicator. In combination with a resistor and capacitor, the tube introduces a time factor before the fifty volts, applied to the circuit when an agent set is operating the equipment, builds up sufficient potential to fire the tube. This discharge, attained only when one of the many relays does not function, closes a circuit bringing up an error light and returning relays to normal position. Regular operation is sufficiently rapid to avoid potential buildup required to complete the error circuit.

Fig. 3. Availability boards at rear of United reservations office telephone sales installation provided inconvenient visual display of flight status prior to Unisel installation.

Ticket Sales Involve Complex Procedures

The seemingly simple and rapid process of making a reservation on an airplane is in reality a complex operation designed to give the customer efficient, convenient service. United Air Lines, typical of major commercial carriers in its reservations set up, employs over 1300 telephone sales agents. The carrier has four major reservations offices, located in New York, Chicago, San Francisco and Los Angeles. The

Chicago office, representative of any of these large facilities, employs a staff of over 280 with personnel on duty 24 hours a day and handles 3500-5000 phone calls daily. Major office divisions include telephone sales, sales records, space sales and sales facilities.

"Our biggest competitors are our best customers" according to a United Air Lines reservations office supervisor. "Off Line" passengers, or those making connections with United Flights from flights operated by other airlines, provide nearly a third of United's business. To handle these off line reservations, as well as local sales and "On Line" passengers traveling through Chicago on other United flights, requires complicated communications and recording facilities.

Operation Base Payload Control, located in Denver, Colorado, is United's focal point for coordinating reservations made in local offices throughout the country. Payload Control, acting as a space "bookkeeper" maintains charts on all flights on which seats are recorded for each date. Individual cities served by United contact Denver's payload control office to report seats they sell in blocks of five. When sales on a certain flight reach a nearly-full status, Denver transmits, via teletype, a stop sales message to all reservations offices. This message is received by the Unisel operator who plugs the flight in the leg day storage racks accordingly. While this procedure is now handled in Denver by employees maintaining inventory records, future plans include a master Reservisor installation in Denver that would feed all other cities availability data electronically.

A battery of IBM machines handles the processing of reservation cards that are filled out by the sales agent in the process of booking each customer. The cards, with information on all facets of the purchase, are key punched and typed for further processing. A sorter and collating machine place the cards in order according to flight number on dates by month and day. The more than 5000 cards handled daily at Chicago are stored until midnight each day. Then they are merged with the other reservation cards by the collating machine, which orders them according to month, day, flight number and passenger name at the rate of 450 cards per minute. Advance reservations are accepted indefinitely into the future.

A manifest for each flight is reported to Denver. These specific records on what passenger will occupy what seat are recorded verbally onto tape that is transmitted to Denver over private line phone at twice the speed of normal speech. Denver then slows down the recording to obtain the manifest. Since Denver does not individually record each seat sold, a space control operation is necessary in the local reservations offices. Space control can then prepare manifests for later phone transmission to Denver. The private phone circuit rented by United has one connection used exclusively for payload control. The second line interconnects other cities.

Teletype systems link reservations offices with those of other airlines as well as with other United sales facilities. Transmitters connecting directly with other airlines are designed to relay messages on incoming tape directly to another line by feeding the tape itself into a transmitter properly set for the desired receiving station. Messages sent out to other United offices are routed to the proper city at the main communications center located at the airport. Individual teletype units handle "Off Line" space requests from other airlines for passengers who must make connecting flights. Future simplification of the message procedure will soon be possible through the installation of an automatic device that will transmit space request messages when necessary at the same time the reservation card is perforated.

Questions about flight arrival and departure are handled through a Flight Information department having its own phone number and utilizing a large board displaying flight data. In addition, Unisel itself provides limited flight information. An agent selecting a flight by the usual destination plate insertion process, and depressing date keys "35" will get a light under flight listings if operation is "normal" or

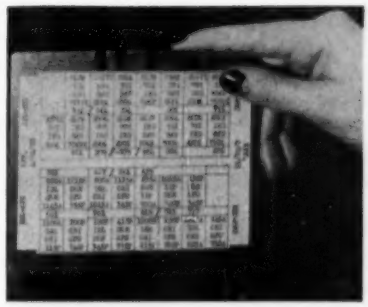


Fig. 4. Metal destination plate has positioned teeth on edges that trip Unisel agent-set switches to start group selection. Flight segments are displayed in groups of eight.

if arrival and departures are on schedule. No light indicates that the agent should check flight information for specific detail on the flight's not operating according to plan.

Another department of the reservations office, Current Control, handles all reservation cards for the current day, as well as wait-list records. Current Control advises Unisel to insert a yellow plug on a current day flight when a wait list exists for the flight. It also makes daily food orders for meals served on flights leaving the city.

Modern commercial aviation harnesses complexity to accomplish passenger convenience. United's new Unisel Reservisor System is a significant step toward more effective sales procedure. Yet Reservisor is only a part of the interrelated communications and filing systems that preserve service amid a large volume of business.

At present, one third of the total office staff deals directly with the public through telephone sales. The remaining two thirds process reservations after they are made. The Reservisor Availability Only System, rather than reducing the number of people in the reservations function, helps swing the division of employees the other way as it releases more personnel for sales agent duty. Customer service is enhanced through instant availability information and selective selling. This emphasis upon the individual air traveler, his problems, and his convenience, is the key to growing aviation leadership in public transportation.

Inductive Coordination

by JOHN F. AHEARNE, EP '57

With the advent of nationwide power and communication systems, the problems of the utilities engineer were increased many times with the addition of problems involving a combination of the two types of systems. As power circuits spread across the nation, it was inevitable that in some regions they would be placed in proximity to telephone circuits. Because the average family is a customer of both the telephone and power companies, the majority of telephone circuits today are paralleled by power circuits. To the telephone engineer, the elimination of extraneous noise caused by power systems is a most critical problem.

The frequencies which the telephone circuit must faithfully reproduce are those in the range of 200 to 3000 cycles per second, the so called voice frequencies. In this range are found most of the frequencies which are used by the human voice in speaking. Faithful reproduction of these frequencies in a telephone circuit will produce clear, easily intelligible conversations. The introduction into the telephone circuit of extraneous noises made up of any frequencies in this range will decrease the clarity of the telephone conversation, perhaps to the point where intelligible conversation is no longer possible. When telephone wires are strung side by side, it is possible for a conversation in one to interfere with a conversation in the other. This phenomenon is known as crosstalk.

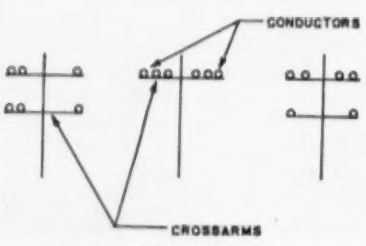


Fig. 1. Pole configurations.

Power, Phone Lines Produce Induction

Crosstalk is a problem for the telephone engineer. Both the power engineer and the telephone engineer are involved when power lines effect telephone circuits. The effect is termed induction; the work done by both utilities to solve the problem is termed inductive coordination. As in any specialized subject, the field of power-telephone interaction has a terminology unique to it. Some of the commonly used terms are as follows:

Configuration: the arrangement of crossarms and wires on a pole. Several different configurations are illustrated in figure 1.

Joint Use: telephone and power circuits occupy the same pole: figure 2.

Roadside Separation: telephone and power circuits on different poles, the poles on opposite sides of the same road: figure 3. Occasionally the separation is greater than roadwidth yet still troublesome.

Exposure: The condition when a telephone circuit is sufficiently close to a power circuit to be effected by it.

Induction noises are caused by currents of the disturbing frequencies in the telephone circuit. These currents are induced either directly by the magnetic flux set up by currents in the power circuit or indirectly by the electric flux set up by the power voltages. In the latter case, the voltage between the power lines themselves or the voltage between the power lines and ground produces an electric force field which alternates with the same primary frequency and contains the same harmonic frequencies as does the power voltage. The proximity to a power circuit of either a joint use or a roadside separation telephone circuit places the telephone circuit in the effective range of this alternating electric field. The electric field induces voltages between the telephone circuit and ground and between the telephone circuits themselves. When two telephone circuits are at different distances from a disturbing power circuit, there is a difference in the voltages induced in them by the electric field of this power circuit. This difference in voltages results in currents between the two telephone circuits, if paths are provided between the two circuits. If the power voltages are sufficiently large and the telephone circuits are within a few hundred feet of the power circuits, the induced currents can become large enough to make a telephone conversation unintelligible. This condition, when the induced currents are restricted to the telephone circuits (with the possible exception of the paths between the circuits), is termed metallic-circuit induction. The voltage difference between telephone conductor and ground can also produce induction currents. When the tele-

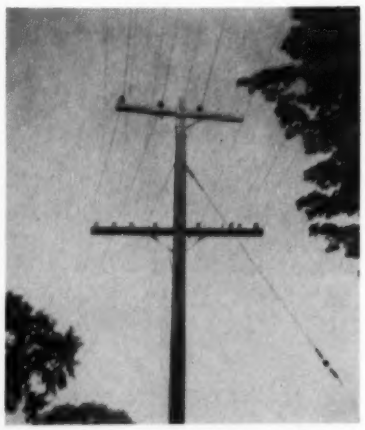


Fig. 2. Joint use of pole showing power conductors above telephone conductors.

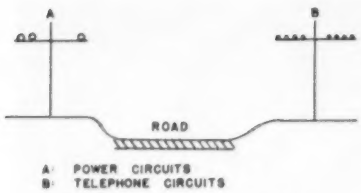


Fig. 3. Roadside separation.

phone wires (singly or in parallel) compose one-half of the induction circuit and the earth provides the other half, the induction is termed longitudinal-circuit induction. Metallic- and longitudinal-circuit induction also occur whenever a telephone circuit passes through the magnetic field set up by power currents.

The method of analysis of the induction problem divides the subject matter into three fields: influence factors, susceptiveness factors, and coupling factors. Influence factors are those which pertain to the power circuits, including wires and connecting power equipment. These factors measure the effect of the various parts of the power system upon the location and intensity of the electric and magnetic fields set up by the power system. A brief description of some of the most important influence factors is all that is possible in this survey article.

Influence Factors Cause Induction

Perhaps the most important influence factors are the wave shapes of the power voltages and currents. If the power waves were pure sine waves of sixty cycles per second frequency, there would be no induction problems. However, most commercial power supplies generate imperfect sine waves. The resultant telephone trouble depends to a great extent upon the degree of these imperfections. In order to standardize wave shape discussions, telephone engineers use the Telephone Interference Factor, abbreviated TIF. Using a TIF curve, an engineer can determine the relative effect of any power frequency upon present-day telephone equipment. In use the TIF weighting is multiplied by the root-mean-square value of that particular frequency component of the power wave, either current or voltage, to give the relative interfering effect. A sample TIF curve is shown in figure 4. This curve indicates that those frequencies near 1100 cycles per second are the most troublesome to telephone equipment.

In a discussion of three-phase circuits, it is convenient to divide the voltages to ground and the conductor currents into balanced and residual components. A balanced component of either voltage or current is one whose effective values in the three conductors are equal and so related that their vector sum is zero. Balanced currents are therefore restricted to the power conductors; residual currents are found in the neutral wire of a 3-

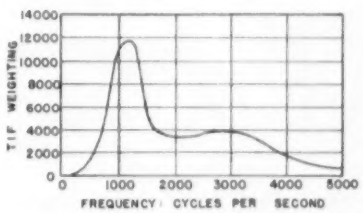


Fig. 4. Frequency weighting curve for TIF.

phase 4-wire system or are present as ground currents in grounded 3-phase, 3-wire systems. These residual ground currents are often the cause of interference problems. A mathematical analysis of a 3-phase system will show that the odd triple harmonics are the prime offenders, i.e., the 3rd, 9th, 15th, 21st, etc. (180 cycles per second, 540, 900, 1260 etc.)

Power configuration is another important influence factor. The effect of balanced components can be considerably lessened if the power conductors are kept close together. Two power conductors will act as a return path for the current in the third; the effect of one of the former will cancel out the effect of the latter if the conductors are close together. The spacing of power conductors has, however, practically no effect on the induction from residual components. In the calculation of induction, the concepts of a neutral plane and of an image conductor are used; the image conductor being as far below the neutral plane as the actual conductor is above it. In electric induction, the neutral plane is essentially coincident with the ground surface. Residual ground currents, which use the earth as a return path, are of great importance in magnetic induction. In this case, the neutral plane may be several hundred feet below the surface of the earth, depending on the harmonic frequency and the earth resistance. Therefore, the exact height above ground of the power conductors is not an important detail in magnetic induction studies.

Conductor diameter is a minor influence factor, slightly effecting electric induction. The use of cable instead of open wire practically eliminates induction from balanced components and reduces induction from residual components.

Telephone Circuits Create Susceptiveness Factors

Susceptiveness factors pertain to the telephone circuits and attached equipment: primarily wires, cables, and telephone sets. The TIF graph shows that the construction of telephone receivers makes them especially susceptible to frequencies around 1100 cycles per second. Telephone circuits can be divided into two general classes, open wire and cable circuits, the terms being self-explanatory. When two telephone circuits are in parallel, a third circuit can be derived from the first two. The economical third circuit is termed a phantom circuit. Two methods of obtaining a phantom circuit are diagrammed in figure 5. The phantom circuit is more susceptive to induction than an ordinary circuit; it is composed of more conductors, and the two sides of the circuit are more widely separated. When cable circuits are used, the wires contained inside the cable are twisted together. Thus they lie in approximately the same regions of the electric and magnetic fields set up by power circuits. However, any inequality in

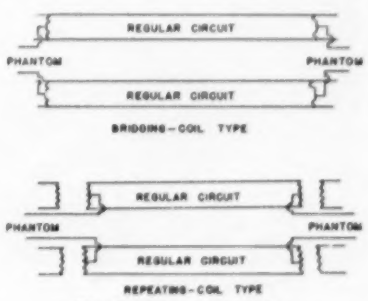


Fig. 5. Phantom Circuits.

line impedances or in line to ground impedances of the conductors may result in induction noise in connected telephone receivers. Line to ground impedance unbalances may exist at the central office, along the line, or at the telephone sets connected to the line. Balancing impedances is an important method of lessening induction effects.

Power, Phone Circuits Combine As Coupling Factors

Coupling factors are those which determine the inter-relation between power and telephone circuits. The separation between the two circuits is a very important coupling factor. Also of considerable importance are the length of the parallel exposure and whether the same conditions prevail throughout, i.e., whether the exposure is uniform or irregular. A coupling factor sometimes overlooked is the earth resistance. Since the earth composes one-half of the residual current circuit, the earth resistance is important in induction studies. In a recent induction survey in Connecticut, computed values were changed by factors as large as one-third when the possibility of changes in earth resistance was considered.

Of course, these are not the only factors considered by the telephone and power engineers when induction problems occur; usually these are the more important factors. A thorough investigation of all the factors can occupy several men for many months. The results of this investigation will be the basis for expensive alterations and additions to the power and telephone systems. In any practical survey of this kind, many approximations must be made. It is the engineer's task to make the correct approximations and to the correct degree.

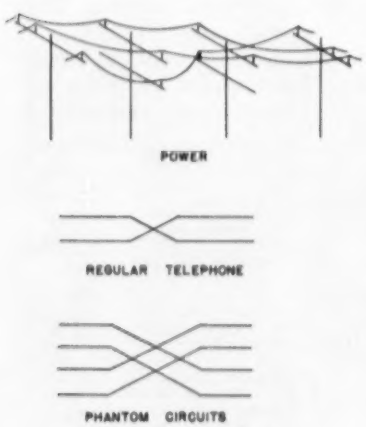


Fig. 6. Transpositions.

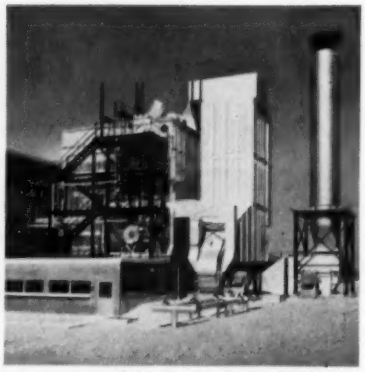
Transposition Remedies Induction

A common method of remedying induction troubles is to alter the power circuits, often by transpositions. In a circuit in which all the lines are maintained in the same general configuration, a change in the relative positions of the conductors is termed a transposition. In total effect, there is little difference whether the power circuits are transposed or the telephone circuits are transposed. In the latter, phantom circuits provide an added complication. Examples of the various types of transpositions are given in figure 6.

Two open wire telephone conductors lie in different regions of the electric and magnetic fields emanating from power circuits. The electric field charges the two conductors to different potentials per unit length. If a path exists between the two conductors, an induction current will result. Transpositions will tend to equalize the induced potentials, considerably decreasing the metallic-circuit induction currents. The magnetic field induces currents in the two telephone circuits. These currents differ in magnitude because the conductors differ in distance from the power circuit. Thus there is a resultant metallic-circuit magnetic induction current which will also be decreased by transpositions. Telephone transpositions will also equalize capacitances to ground and thus improve the circuit balance. Residual current induction is not effected by transpositions.

Station Transformers Reduce Harmonics

Another approach considers the generating station, figure 7. Transformers properly connected between the generators and the distribution line eliminate triple harmonic voltages. In small distribution systems, transformers may be uneconomical and the generators will be connected directly to the lines. If the generators are built with a two-thirds coil pitch, they will not drive triple harmonic currents through the circuit. They will, however, offer a


—*Public Service Co. of New Mexico*
Fig. 7. A typical small generating station.

low impedance to triple harmonic currents arising elsewhere in the circuit, e.g., from motors fed by the power system. If the generators are not designed to eliminate the triple harmonics and the lines are not fed through proper transformers, other methods may be applied to reduce the disturbing frequencies. A reactor may be placed in series with the ground wire of each generator supplying a 3-phase 3-wire system. The reactor (essentially an inductance) will decrease the residual components of all frequencies; it is not a selective device. After a lengthy survey, the engineer may conclude that eliminating one or two frequencies from the residual currents will reduce the induced noise to a satisfactory level. The power company will then install one or two wave traps in the generator ground. These devices, each composed of an inductance and capacitance in parallel, can be tuned to eliminate a narrow band of frequencies. Therefore, since the band width between harmonic frequencies is greater than that encompassed by a wave trap, each frequency to be eliminated requires a separate wave trap.

Inductive coordination is only one of the myriad problems facing the communications engineer. Weather, noise, the human element, the constant demand for progress, and the necessity for economy are a few of the other numerous factors that must be considered by the telephone engineer. He must be a combination of a practical scientist and an economy-minded engineer. Thus the job of the telephone engineer can be quite arduous, but it is most always interesting.

The Trend to Prefabricated Housing

by LEONARD PISNOY, CE '57

Rudyard Kipling said,
"I tell you this tale which is
strictly true,
Just by way of convincing you,
How very little since things
were made,
Things have altered in the
building trade."

If Mr. Kipling were alive today his thoughts would be completely changed.

During the last thirty years the American people have seen rapid strides made in the design and the construction of houses. The needs of the masses for adequate low cost housing have presented industry with the problem of reducing costs. In recent years this problem has been of national concern.

Several attempts have been made to provide the public with adequate low cost prefabricated housing. Such housing, in contrast to conventionally built homes that are constructed on the site, consist of entire wall, floor, or ceiling panels that are made at the factory prior to being assembled on the building foundation.

The development of the prefabrication industry is similar to that of most industries. The number of manufacturers has steadily increased, and standards of construction have been formulated among solvent corporations.

Sears, Bemis, Fuller Pioneer Prefabs

After 1900, Sears Roebuck, with its large mail order business, initiated the selling of a pre-cut house. Here the basic idea of standardization of materials and sizes, so necessary in the mass production of houses, began. By 1920 the potentialities of prefabrication were recognized by leading industrialists. Albert Bemis, with appropriations from Bemis Industries, sponsored research in prefabrication at Massachusetts Institute of Technology. Mr. Bemis spent more time and money in the development of prefabrication than any other individual. His resources were instrumental in establishing the ideas, advantages, and growth of this industry. His most important contribution to the building industry was the cubical modular method of design commonly called modular coordination. In 1927, Buckminster Fuller announced his idea of "Dymaxion." The purpose behind this theory was to maximize the performance of a house per pound of material contained in its structure. To make this applicable, he proposed the Fuller Dome shaped house. Mr. Fuller symbolizes a group of men who concluded that the design of the house must be fundamentally altered if the housing situation is to be met.

As the depression altered the economy of the nation, The United States Government took an active interest in prefabrication. This was an outlet for the unemployed and an investment in the future. The government agencies which experimented with, built and sold prefabs were The Farm Security Administration, and The Tennessee Valley Authority. This resulted in the production of low cost, demountable houses. Through their research the Pierce Foundation, The Bemis Foundation, Purdue University, U. S. Forest Products Laboratory, National Bureau of Standards, and The Federal Housing Administration lent impetus to the industry.

By 1939 there were about thirty firms which were manufacturing and selling prefabs on a steady basis. No manufacturer in the prefabrication industry at this time had achieved commercial success. This was because no one had yet accumulated enough technological information or capital to develop an integrated building organization whose operations extended from the procurement of materials through

—*Admiral Homes, Inc.*

Fig. 1. Assembly-line construction of walls.

manufacturing, selling, financing, erecting and servicing the home.

The Government once again aided the industry by purchasing prefabs. During World War II the Government had built over 200,000 prefabs because of their demountability, the reduction of "on the site" labor, and consequently a minimum congestion problem.

Many firms attained strong financial positions, and many new enterprises entered the field during the war. At this time the industry encountered two major obstacles, poor marketing procedures and an adverse public opinion. The latter has been attributed to the linking of prefabs with flimsy Army barracks. The public was still not ready to accept prefabrication. In a Fortune Magazine poll of August 1946, 70% of the public had heard of prefabs but only 16% were interested in living in them. The main reason for this result was that people believed prefabricated houses were unsatisfactorally constructed. Lightness was evidently confused with weakness and speedy erection with short life. Consequently advertising was necessary to educate the public to the benefits of prefabrication.

Prefabs Are Assembly Line Produced

At the present time over 85,000 prefabricated homes are being built each year. Although this represents only a small share on the current one and one quarter million homes built each year, prefabrication does have many advantages with respect to conventional construction. The entire house, except for the foundation, is constructed under controlled conditions at a factory. All of the building materials are checked for quality and size. The various wood products are joined together by glue rather than by nails. Since glue has a greater strength, the finished product is more durable. The only operation that is not controlled by the manufacturer is the erection of the building. However, trained men are employed to do this job. The entire prefabricated house can be erected in a matter of hours, saving the consumer time, energy, and money. Prefabs can be economically shipped to areas up to 300 miles from the factory.

A set of performance standards for prefabricated houses has been published by the National Bureau of Standards, in conjunction with the Prefabricated Home Manufacturer's Institue. The latter organization deals with industry promotion, marketing, employer-employee relations, technical problems, accounting and statistics, materials, and government relations.

The main steps in the assembly line production of a prefab wooden house are:

1 - The floor is put in.

2 - Pre-assembled walls and partitions are installed, and the plumbing and wiring are started.

3 - The roof framing is built while the plumbing and wiring are completed.

4 - The roof shingles are placed, the heating unit is installed, and a prime coat of paint is applied.

5 - The wall board and plaster are put on and the sashes are installed.

6 - The second coat of paint is applied.

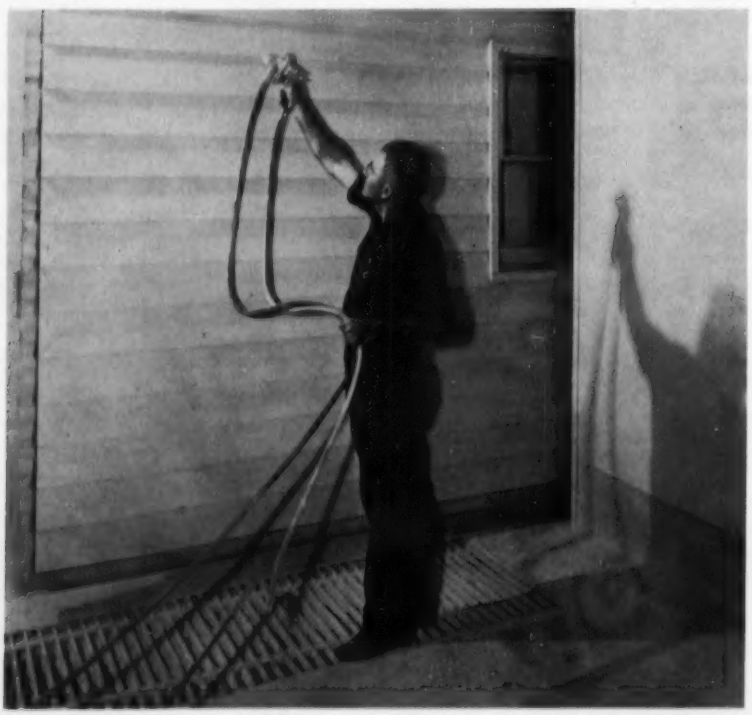
7 - The interior work is completed.

8 - The interior and exterior painting are completed.

9 - The fixtures are installed.

10 - The house is inspected and preparations are made for moving it.

As one can readily see from the above description, each operation is an integral part of the prefab building process. Each building operation is so designed as to employ the optimum amount of manpower. This avoids unnecesary delays which often result in conventional type building. No longer will plumbers be in the electricians' way, etc. It also avoids the possibility that materials may not be on hand and that an adequate supply of competent labor is available.. The above description is one of the many types of assembly line productions within the prefabrication industry.



—*Admiral Homes, Inc.*

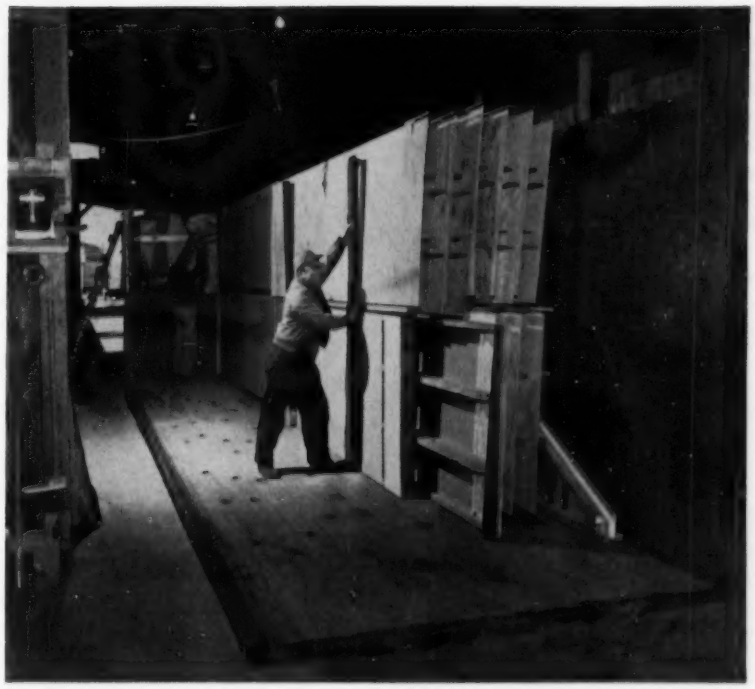
Fig. 2. Paint spray booth at the factory.

Unions Encounter Job Problems

Much discussion has been provoked to the possible conflicts of union ideas of construction and those of the prefabricator. Fortune Magazine of April 1946 states, "One of the most highly publicized obstacles is the the philosophy of the building trades union of The American Federation of Labor. This philosophy is based on the premise that there is a definite limit to the amount of building to

be done. Therefore the work must be spread out among as many union members as possible and made to last as long as possible." This article seems to indicate that the unions are the major obstacle in the development of modern, efficient low-cost housing.

In speaking with the president of the Carpenter's local Union #1649 at 95-01 103rd Avenue, Ozone Park, New York, the author discussed the union's general ideas in reference to new techniques of construction. He felt that the unions will welcome any new ideas of production, replacement of products, and actual construction provided that the same number of union men will be employed. In many cases he felt that prefabs were inferior to conventional construction and hence some local unions might offer opposition. But, in general, union opposition has diminished as unions are realizing that everyone will benefit if adequate housing can be provided.



—*Admiral Homes, Inc.*

Fig. 3. Loading of house into a trailer.

Fuller Home Typifies Prefabs

The construction of prefabs has developed along two lines. One theory states that in order to reduce costs, the design of the house must be radically altered. The other, which has obtained greater public approval, is to prefabricate a conventional home in a factory. An excellent example of the former is the Fuller House, which was put into production in 1947. The purpose of the circular dome shaped house of Mr. Fuller's is to provide a maximum floor area using a minimum amount of materials. This is similar to the arch-type of construction. The house is made of aluminum, stainless steel and plastics. It weighs approximately three tons instead of the usual 100. Almost all of the materials are in tension, rather than compression. This is because metals are stronger in tension than compression. Its streamlined contour reduces wind drag, and therefore heat losses are minimized. The shiny outer skin reflects radiation making the house warmer in the winter and cooler in the summer. Since the interior is entirely free of structural members except for the center mast, room arrangement is flexible. The entire house can be shipped knocked down, with its various framing members and skins packaged into a cylindrical container 4½ feet in diameter and 16 feet long. The actual construction of this house was to be done in an aircraft plant where the necessary equipment, labor, and machinery were available. Since the aircraft industry was in need of new products to manufacture, Fuller's ideas were received with great exuberance.

Fortune Magazine, writing about the Fuller House in the April 1946 issue, said, "When one reviews all of the known facts about the house . . . its spaciousness, and the ease of maintenance, the logic of the manufacturer and the superlative quality of its materials . . . it is difficult to escape the conclusion that this is the house of the future." 37,000 people wrote to The Fuller Houses Inc., expressing their desire to purchase this home for $6,400. When all of the tumult was over, Fuller had only manufactured two homes. The necessary capital could not be obtained to keep the corporation in business and as a result it folded.

The American people were not ready to accept the radical design and standardization of the Fuller Home. Mr. Fuller's ideas although approved by outstanding authorities, were not accepted by the public. Because of the engineered design, the choice of materials, and the manner of construction the Fuller Home will meet the expectations of Fortune Magazine. This will occur only when the American people accept Fuller's basic philosophy of radical design to meet the requirements of low cost housing.

Mr. Fuller definitely realized that public opinion plays a vital role in the development of any new method or idea, when he said, "Sooner or later people are going to get around to the realization that the only way to make dwellings in an industrial society is to make them the way every thing else is made . . . in factories."

Modules Provide Construction Ease

The prefabrication of conventional type homes has seen enormous progress since modular coordination was introduced by Frederick Heath in 1925. Today there are over 600 firms producing modular products. A module is a unit measurement, being any number of inches or feet. It is applied to width,

depth, and height of the components of a house. Through the efforts of Albert Bemis, the four inch module has seen many practical applications. It has become the standard of many homes. The purpose of using a standard 4" module is that all sizes of the components of a building (wall board, brick, wood panels, beams, tile, sash, etc.) will be manufactured in multiples of four inch units of length, for example (wall board size 48" x 72"). If all building materials and components were manufactured in coordinated sizes and with provision for certain standardized joints and constructions, they could be assembled with relative ease and little waste, into a wide variety of structures designed along modular principles. An example of this is the placing of sash in the opening of a brick wall. Each brick can be considered as two modules since its size including room for the mortar joint is 4" x 8" x 4". The sash are also in multiples of four inches so that it is only necessary to cut the brick in half, rather than formerly having to cut it into minute pieces. The floor layout of the house is in 4" multiples which also eliminates waste in cutting brick. Even more important, many products now independently dimensioned, like staircases, which are rarely mass produced, could be produced and marketed in stock sizes in the same manner as windows and doors. The reduction of site costs and a partial shift of the building process from site to factory are the inevitable results of a successful program of modular coordination.

The four inch module was chosen because:

1—It is small enough for ample freedom in architectural design, and for flexibility in equipment layout.

2—It is large enough for manufacturers to reduce the number of stock sizes and still satisfy consumer demand.

3—It coincides with the dimensions of a great many building materials already standardized, and is applicable to present construction practices.

4—It is a unit measurement with which architects, builders, masons, and carpenters are already familiar.

5—It approximates 10 centimeters, the basis proposed by metric countries working on the same problem.

—*Admiral Homes, Inc.*

Fig. 4. Erection of a wall section at the site.

It has been suggested that a larger module of four to 16 feet be used in the construction of homes. The major reasons for this are that a larger wall section will require lighter than conventional type construction to facilitate the handling of sections without the aid of machinery. A lighter member has a lower transportation and erection cost. Since machinery will not be used, every structural member in the section must be designed to perform a specific function. Consequently the amount and type of material used will be determined by exact engineering computations. In conventional building, construction is generally by "the rule of thumb," which results in overdesigned structures and consequently a waste of material and labor. Larger wall sections mean fewer joints; therefore, a saving in labor will result in erection and at the factory. A larger module would sacrifice much of the flexibility permitted by an extensive range of room sizes in the exchange for the advantages of mass production. The Small Homes Council of The University of Illinois has developed a series of room units of the basis of a four foot planning module. These room units can be put together in a variety of ways to form a floor plan for a house. They have suggested that floor plans be based on the four inch module, with panel fabrication and room sizes on the four foot module.

The building industry should use a module which is in accordance with the principle of economy, namely that the module should be large enough to permit mass production of building products, and small enough so that a large variety of floor patterns can be evolved to meet the demands of the consumer. The modules as proposed by The Small Homes Council of The University of Illinois seems to fit these two categories. However, retooling costs are prohibitive in many plants of the building industry.

There are two major reasons why prefabricators do not at present make greater use of modular design. The first is that they have been standardized on only a limited number of house plans. With so little variation of design complete modularization imparts small advantages. The second is that the building industry has just begun to standardize dimensions on a moduar basis, and much of the early coordination has been done by the brick, tile, and masonry unit manufacturers, so that it is of little use in prefabrication.

At the present time the industrial production of prefabs is becoming sufficient to obtain mass purchasing of materials at lower prices. As the output of the various manufactuers increased a sizeable reduction in cost will be obtained by the consumer.

In all prefabs materials are chosen for ease of procurement and use, for adaptability to the prefabricator's pattern of operation, and for technical satisfaction of normal requirements. The special qualities required in materials by most prefabricators are light weight, strength, durability, and adaptability to normal fabrication and transportation methods. All of the above characteristics lead the manufacturer to approach the optimum, low cost housing.

Promotion is Key To Prefab Acceptance

Since it is only economical to ship houses 300 miles from the prefabricator's factory, it is necessary for a manufacturer who wishes to have national distribution of his product, to set up small plants throughout the country. Consequently, the prefabricator has to have a large organization. In a large organization the manufacturer can concentrate on creating a favorable demand for his product through national advertising. Such promotion is definitely needed be-

cause the promotional campaigns now carried on have not created the public interest in prefabrication which the industry deserves and needs. An alternative to this is national advertising by several manufacturers with the aid of The Prefabricated Home Manufacturers' Institute.

As the quantity of prefabs sold increases, each manufacturer will be in a more favorable position to announce to the public the relative advantages of his product and the merits of low cost prefabricated housing. However, economy in construction can only be obtained by having the same crew do the same job at the same place each day, by standardization of materials, and by mass purchasing. In a factory men are not subjected to the climatic conditions present in the area. In a locality as the Northeastern part of the United States construction is diminished during the winter. The temperature range in which the maximum output of worker can be obtained is from 65° to 75°F. Consequently greater efficiency can be obtained in a factory. Another result of this is that the manufacturer can accurately predict the length of time for the production of a house, and its cost. Men travel to the same factory each day. They do not have to readjust themselves to new working conditions and problems at each site. All of these arguments blend themselves into the greater utilization of manpower.

The problem of whether prefabricated housing can solve our housing problem, by providing low cost housing, is in great dispute. There are no facts as to the relative costs of the exact same house being conventionally built on the same land as compared with a prefabricated one. In an interview, Professor Glenn H. Beyer, Director of The Housing Research Center at Cornell University, stated that in the low price field, prefabricated houses provide better materials for the same cost per square foot as a similar size conventional house built for the same price on an identical location. Professor Beyer further said that prefabs would compare favorably to a large size housing project, as Levitt built. Assuming that the prefabricator could mass purchase his materials as some conventional builders do, he should be able to build a comparable project at a lower cost. Beyer also pointed out that the prefabrication industry is relatively new, and that prefab war-time construction and some incompetent manufacturers have hindered progress in this industry by giving it adverse publicity. This once again shows the need for a well conducted advertising program to be carried out by the solvent enterprises with the aid of The Prefabricated Home Manufacturer's Institute.

—*Admiral Homes, Inc.*

Fig. 5. Completing the roof.

Prefab Progress Promises Bright Future

The industy has definitely made great strides since its formation. In the past two years there has been striking improvement in the public acceptance of low cost prefabricated housing and in the procurement of necessary capital to finance this venture. Today almost all building code conflicts have been eliminated and union problems are becoming extinct. National Homes, the largest manufacturer of low cost prefabricated houses, estimates that it will sell over 35,000 homes during 1955. This is a 300% increase from 1954. An estimated 77,000 houses were built by the prefabrication industry in 1954. This represents about 7% of all new single-family houses put under construction during that year. The industry prospects for 1955 are 10% of all new houses.

Perhaps the most important achievement of prefabrication has been its use in the conventional type home. Over 90% of current home construction contains prefabricated products.

As the shift of labor continues from the site to the factory, the public will be provided with adequate low cost housing. Prefabricated housing does offer the public a positive approach to solving its housing problem.

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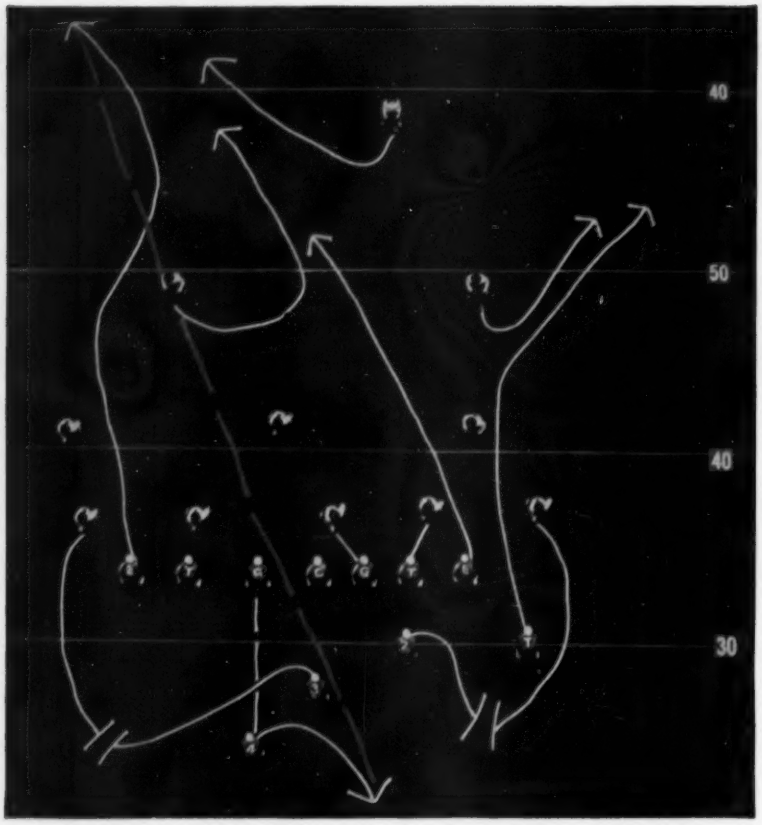

aerial attack

Q: What has *this* to do with the aircraft industry —and you?

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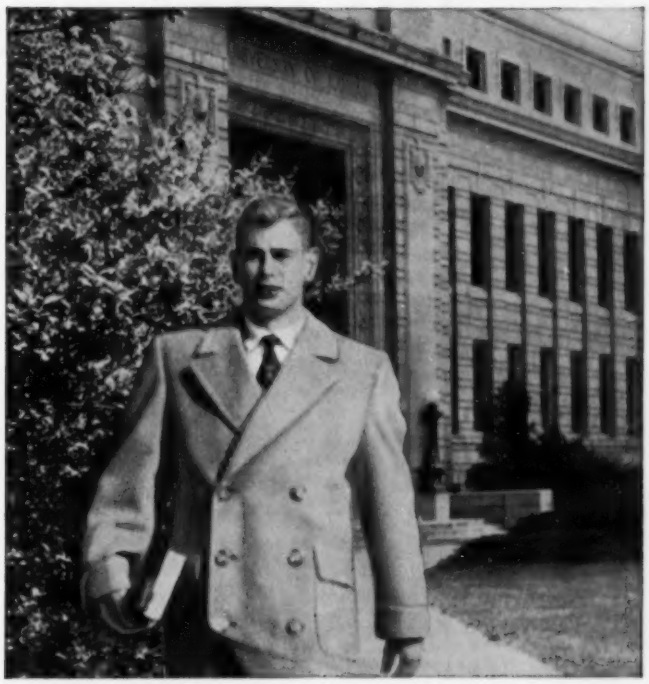
Dave Johnson asks:

What's involved in production work at Du Pont?



DAVID L. JOHNSON, JR., expects to receive his B.S.Ch.E. from the University of Kansas in 1956. He is very active in campus affairs, president of Alpha Chi Sigma and a member of several honorary engineering fraternities. Dave is interested in learning more about production work in the chemical industry.

JAMES L. HAMILTON is one of the many young engineers who have been employed by Du Pont since the end of the war. After service in the Navy, Jim got his B.S.Ch.E. from the University of West Virginia in June 1948, and immediately joined Du Pont's Repauno Plant at Gibbstown, N. J. Today, he is Assistant Superintendent of the dimethyl terephthalate area at this plant.

Jim Hamilton answers:

Well, Dave, I've been doing production work at Du Pont for about seven years now, and I'm still getting involved in new things. That's what makes the work so interesting—new and challenging problems arise all the time.

To generalize, though, the duties are largely administrative. That's why effectiveness in working with others is one of the prime requirements. Teamwork is important in research and development work, for sure. But it's even more important in production, because you work each day with people having widely different skills and backgrounds.

A production supervisor needs a good understanding of engineering and scientific principles, too. He has to have that to get the best results from complicated equipment—but he doesn't necessarily need the specialized training that goes with research and development work. A real interest in engineering economics and administration is usually more helpful to him here than advanced technical training. The dollar sign's especially important in production work.

It all adds up to this, Dave. If you enjoy teamwork, and have a flair for large-scale, technical equipment, then you'll find production work mighty rewarding.

A MORE COMPLETE ANSWER to Dave Johnson's question about production work is given in "The Du Pont Company and the College Graduate." This booklet describes in detail the training, opportunities and responsibilities of engineers who take up this kind of work at Du Pont. Write for your free copy to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Delaware.

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BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

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BRAIN TEASERS

'Way back last May, lads, we printed some answers to April's Brain Teasers, and asked no more questions. But we're up again.

Each month, in this section of the Engineer, there will appear three problems, each difficult enough, we think, to appeal to red-blooded brooders. Their solution will require imagination and ingenuity, but will not require the use of esoteric mathematical methods.

Answers for the first two problems of each month will appear on the "Stress & Strain" page of the same month (for the benefit of those who find it difficult to remember for a whole month that they're dying to know the answer to such-and-such question).

The answer to the third problem will appear in the issue following the issue containing the problem. This problem is for contest purposes, and here are the rules: Send your solution, complete, by post card or letter, to the *Cornell Engineer,* Lincoln Hall. The earliest-postmarked correct solution will be judged winner for the month. Prize to the sender will be three dollars (!), his (or her) solution will be printed, and his or her photograph (if student), will be included in the next month's section. There you have it: here are the problems. Do at least *try* the third.

Number 1:

A contractor spent $1185 in buying additional dump cars, switches, and portable track sections, which cost $90, $35, and $15, each respectively. The number of switches exceeded the number of cars by 4 and the number of track sections was twice as many as the number of cars and switches together. How many of each did the contractor buy?

Number 2:

A farmer is located 12 miles from the nearest point on a straight railway. The railroad company agrees to put a siding at any place he designates and haul his produce to a town eighty miles from his nearest point on the railroad for five cents a ton per mile. If he can haul by wagon to the railroad for thirteen cents a ton per mile on a straight road to the railroad, where should he have the siding placed in order that his transportation costs shall be the least per ton to the town?

Number 3:

Given the following four propositions—

a) If a Mathematician does not have to wait 20 minutes for a bus, then he either likes Mozart or else whiskey, but not both.

b) If a man likes whiskey, then he either likes Mozart and does not have to wait 20 minutes for a bus, or else he does not like Mozart and has to wait 20 minutes for a bus, or else he is not a mathematician.

c) If a man likes Mozart and does not have to wait 20 minutes for a bus, then he likes whiskey.

d) If a mathematician likes Mozart, then he either likes whiskey or has to wait 20 minutes for a bus. Conversely, If he likes whiskey and has to wait 20 minutes for a bus, then if he likes Mozart he is not a mathematician.

Determine under what conditions a mathematician must wait 20 minutes for a bus. (Solution will appear in the December issue).

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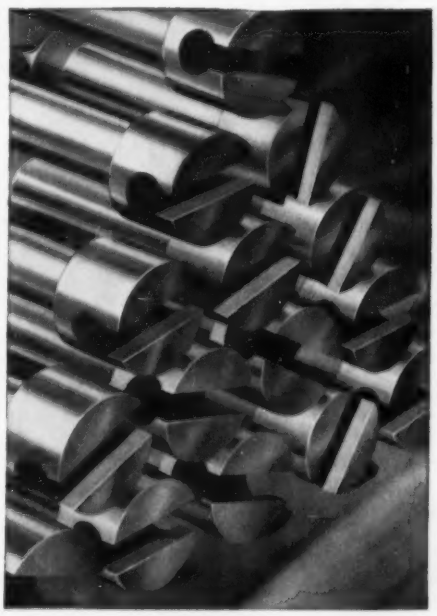
Another page for **YOUR STEEL NOTEBOOK**

The steel that could take anything but a bath



In steel mills and warehouses, a roller leveler straightens wide sheets and heavy plates between powerful steel rolls.

Stress on the rolls is tremendous. To make them strong and tough enough, one manufacturer used an alloy steel, 52100. Then, to make the rolls *hard* enough, they were heated to a high temperature and quenched in a liquid bath. But the severe quench was causing many of the rolls to warp.

The roll maker took his problem to Timken Company metallurgists, asked if he could make rolls from 52100 steel that wouldn't distort in quenching. They said yes—if the steel were uniform from lot to lot in analysis and hardenability.

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The roll maker switched to 52100 steel made by the Timken Company. He found the steel was uniform from lot to lot, heat to heat, year in and year out. Result: he was able to standardize heat-treating practice. Distortion was practically eliminated.

The Timken Company constantly solves steel problems like this one by furnishing steels to the most exacting specifications. Timken Company metallurgists are specialists in fine alloy steels. And they use the most modern quality control methods to assure uniformity, time after time after time.

Want to learn more about steel or job opportunities?

Some of the engineering problems you'll face after graduation will involve steel applications. For help in learning more about steel, write for your free copy of "The Story of Timken Alloy Steel Quality." And for more information about the excellent job opportunities at the Timken Company, send for a copy of "This is Timken". Address: The Timken Roller Bearing Company, Canton 6, Ohio.

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

Prominent Engineers

Here are three of the many Cornell engineering students who are outstanding in some phase of Cornell life.

John Rosenbaum, EP '57

Students of advanced science are usually pictured as quite studious young bookworms and extremely inactive outside of their sheltered little academic world. Cornell's engineering physics program contains many of these apprentice scientists, but it also numbers many exceptions among its promising group. One of the latter is John Rosenbaum, a pleasant, unassuming senior who is one of the mainstays of Cornell's spiked shoe teams.

John was groomed for track at Atlantic City High School, near his home town of Brigantine, New Jersey. Since coming to Cornell, John has become the leader of the University's cross country team and the number one miler of the track team. He is captain of this year's cross country team and defending Heptagonal cross country champion, having won the title two years in succession. As a varsity miler, John's best time is 4:19, although the coming spring will see this time lowered. John is also defending Heptagonal Indoor Mile Champion.

—Photo Science

JOHN ROSENBAUM

He has been Recording Secretary of Beta Theta Pi fraternity and was a member of Aleph Semach, junior men's honorary. As a hobby, he does surrealistic drawings. John is interested in biology and medicine; he may go into the latter field or into biophysics.

John believes that the liberal electives given Cornell's engineering students are very valuable, especially to those students whose required program includes many science courses. These courses tend to develop the idea that science is the only answer to life. The liberal courses provide the necessary opposition to this single-mindedness.

* * *

Karl Menger, EE '58

Winner of the Eta Kappa Nu award for 1954-55 is Karl Menger. This award is given to the "Outstanding Sophomore EE," academic record being one of the primary reasons for selection. Karl has a cumulative average of 92.

Karl is a member of Lambda Chi Alpha fraternity, where he is active in intramural athletics. He also is competing for the editorial board of the Cornell *Widow*, one of the country's outstanding college-humour magazines. Karl's interest in amateur radio is evidenced by his holding a Class B license; his call letters are W9TOX.

—Photo Science

KARL MENGER

He believes that an engineering curriculum in the modern age should not contain liberal courses. Modern technology has advanced to such a stage that the five years in college could best be utilized in acquiring technical knowledge. The engineer who is interested in other fields can devote his spare time to reading in them.

* * *

George Sauter, EP '57

George Sauter is the third engineer spotlighted this month. Like many Cornell engineering students, George does not devote all of his time to studies. As business manager of the Cornell Men's Glee Club, George has one of the most responsible student positions on cam-

pus. He is in charge of all concerts and business arrangements for an organization which annually sings before 25-50,000 people. His largest task is preparing for the annual spring tour of the glee club. He has already begun arranging for these concerts, which will probably be held in Albany, Springfield, Boston, Westchester County, Nassau County, Essex County, Wilmington, Baltimore, and Washington, D. C.

—*Photo Science*

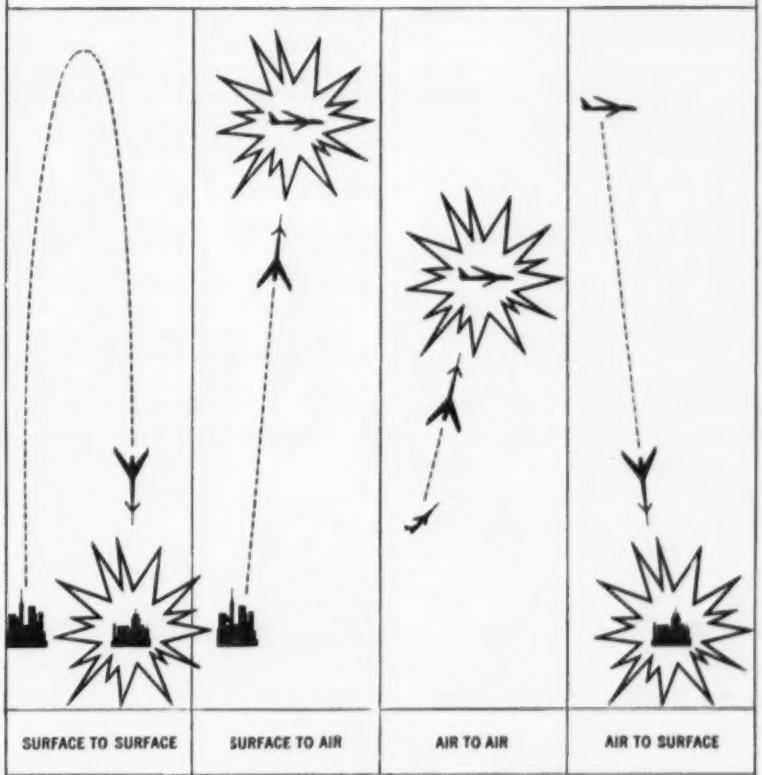
GEORGE SAUTER

This year the glee club and his engineering physics work have prevented this senior from spending very much time on the golf links; due to this, he has not yet this year gone around in under 84. George is a member of Kappa Sigma fraternity; he has been Pledge Master and is active in intramural sports.

In the academic field, George has done far above par work, making the Dean's Honor List twice in the past three years. George believes that Cornell's engineering college is the finest in the country, and he is particularly enthusiastic about the liberal courses which one may sometimes elect.

By courtesy of the Naval Department, he has spent the past three summers touring London, Edinburg, Oslo, Copenhagen, Monterey, and Guantanamo Bay, Cuba. In these travels, the most beautiful sight was the fjord leading to Oslo: multi-colored cottages line the mountain-rimmed fjord and unnaturally green fir trees trim the scene.

GUIDED MISSILES



Nearly all guided missiles require specialized and highly advanced electronic systems of miniature proportions. These systems may include servo-amplifiers, microwave receivers and transmitters and extremely efficient though compact power supplies. The performance objectives for this equipment would be difficult in conventional engineering applications.

At Hughes, the achievement of such objectives in the very limited space and under stringent environmental conditions of the modern guided missile provides an unusual challenge to the creative engineer.

Positions are open for Engineers or Physicists with experience in systems analysis, electronic guidance systems, infrared techniques, miniature control servo and gyro systems, microwave and pulse circuitry, environmental testing, systems maintenance, telemetering, launching systems and flight test evaluation.

Scientific and Engineering Staff

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William M. Leonard

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates, and former students and to establish closer relationship between the college and the alumni."

Over the past twenty-five years, there has been a silent revolution among the top management ranks of American industry.

A generation ago, even less than that, top management posts of enterprises based on engineering were filled almost exclusively by executives who had little real knowledge of personal identification with the operations of the businesses they headed. Most of them were men primarily interested in finance or were hand picked agents of those who were. They knew a good business when they saw it but would have been hard put to make by themselves the vital operating decisions. For these they had to depend on the competence of the first sergeants, well buried down the line.

The great depression, the collapse of financial empires and "the old man with the scythe" hastened the passing of the old guard. The finishing touches were provided by the constantly increasing tax rates and high-powered competition. The days when a business enterprise could be run by what amounted to remote control and at far less than its best possible efficiency have gone forever. Top management today must know what goes on down among the factory wheels or the business goes down the drain. The high and mighty corporation executive of yesterday who spent most of the day reading the stock ticker has given way to a new generation of what are aptly called professional managers.

Today's top-flight executives, for the most part, are men who have climbed the ladder in their chosen industries. For a whole, many of those who displaced the financial titans were of the Horatio Alger office-boy-to-president tradition. Even these are now becoming few and far between because of today's need for technical knowledge. However, engineer to president or even chairman of the board is becoming almost the rule.

In short, yesterday's pinnacle for the engineer was something in the order of district operating superintendent, chief designer or top man in a research laboratory. In today's business world he can be called upon to forsake his slide rule for an administrative office as vice president, president or chairman of the board. As a matter of fact, I know one board chairman who still hides a slide rule in the handkerchief pocket of his jacket.

It is easy to understand why there is a definite advantage in having an engineer make the top policy decisions of a manufacturing or operating company. His engineering training and experience enable him to bring real understanding to bear on decisions affecting the plant operations. But what American business companies are beginning to find out is that the engineer's precise thinking and methodical approach to any and all subjects are effective management tools in fields as far from the customary range of calculus as personnel administration and public relations.

Perhaps, there are the purists who will argue "But this is not engineering." However, they will be outnumbered by those who consider that the progression from the slide rule to the baton, besides being rewarding to the individual, is beneficial to the well-being of both individual business enterprises and the whole economy.

We live in a civilization which is based on technology. Why should it not be for the best that its component parts be run by the men who designed it?

WILLIAM M. LEONARD

ALUMNI ENGINEERS

William H. Kreamer '40, M.S. in M.E., has been promoted to Chief Plant Engineer of the Roanoke plant of the American Viscose Corporation. The Roanoke Plant is one of eight large plants which manufacture rayon fibers, cellophane, and filatex.

Employed by the American Viscose Corporation since 1940, he has gone from Staff Engineer to his present position. Previous to 1940 he was an instructor in Descriptive Geometry and Engineering Drawing at Cornell. He received a B.S. in M.E. from Renssalaer Polytechnic Institute in 1937.

Mr. Kreamer is the 1954-55 chairman of the Virginia Section of the American Society of Mechanical Engineers and president of Southwestern Virginia Engineers, Roanoke, Va. He is also a member of the American Welding Society, the Virginia State Chamber of Commerce, and the Board of Directors of the Roanoke Lions Club. In addition, Mr. Kreamer was recently selected by the Virginia Tech Epsilon Chapter of Pi Tau Sigma for Honorary membership in their fraternity.

Joseph Bevacqua '24, has for 30 years been in construction work and is with Helenlale Construction Co. in Rochester, where he lives at 145 Druid Hills Park. Joe is a director of W. C. Zink, Inc., the Rochester General Hospital, and National Home Builders Association. He is a member of the Chamber of Commerce and Safety Council of Rochester and chairman of the Monroe County Planning Commission. He is also a member of the Cornell Club of Rochester and Rochester Club.

Wilmer C. Swartley M.E. '30, general manager of television station WBZ-TV, has been elected to the new office of vice-president of the Boston, Westinghouse Broadcasting Co., Inc. A member of the Westinghouse organization since 1930, Swartley was general manager of radio station WOWO in Fort Wayne, Ind., from 1938-40, when he became general manager of WBZ-WBZA, Boston-Springfield, the second Westinghouse broadcasting property. WBZ-TV was established under Swartley's direction in 1948 and was New England's first commercial TV station. He is married and has one daughter, Ariel. Address: 254 Highland Avenue, West Newton 65, Mass.

John S. Walter E.E. '33, 256 North Regent Street, Port Chester, is assistant industrial relations manager for Standard Oil Co. He was formerly with Lago Oil Co., an Esso subsidiary in the West Indies.

Alex Dann C.E. '07, 1207-A-Beaver Road, Sewickley, Pa., has retired as executive vice-president of Dravo Corp., after forty-two years with the company. In 1913, he joined Dravo Contracting Co., forerunner of the present corporation.

—*Alumni News*

ALEX DANN

When Dravo was organized as a corporation in 1930, Dann was elected a vice-president and director. Four years later, he was elected executive vice-president. Prominent in Pittsburgh civic affairs, Dann has been a director of the Pittsburgh Chamber of Commerce since 1943. In 1947, he helped organize the Labor-Management Council of Pittsburgh.

Richard H. Jones, Jr., B.C.E. '46, '47, was appointed vice-president of Chris Andersen Erecting Co., Inc., Perth Amboy, N. J., April 1. His address is 271 Oak Street, Ridgewood, N. J.

Frank M. Watson M.E. '31, was appointed last August divisional chief engineer of design and test, Motor Truck Division, International Harvester Co. Engineering Laboratories, Fort Wayne, Ind. Watson's address in Fort Wayne is 1320 Somerset Lane.

Albert W. Dauer B.Chem.E. '48, is a production development engineer in the magnesium department of Dow Chemical Co., Freeport, Tex. He is married and lives at 124 Pecan Lane, Lake Jackson, Texas.

Karl W. Mueller M.E. '32, has been appointed to the newly-created position of vice-president of operations for Trailmobile, Inc., a leading manufacturer of highway truck-trailers and a subsidiary of Pullman, Inc. He was formerly works manager of American Chain & Cable Co., Inc., Reading, Pa. His address is 140 Andover Avenue, Lincoln Park, Pa.

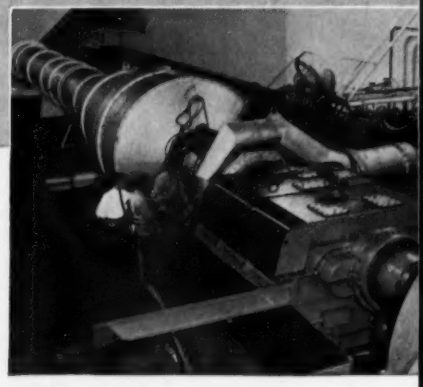
Sam K. Brown, Jr., B.E.E. '41, is now employed by the General Electric Co. as District Sales Manager-Air Force for the Washington, D. C. District of the Electronics Division. He was formerly staff assistant in the office of the Assistant Secretary of Defense (Research & Development).

Fay McCleeland B.Chem.E. '44, left government service last year after three years with the Office of Synthetic Rubber in Washington, D. C. He is now an associate engineer in the plastics laboratory of International Business Machines Corp., Endicott, New York.

Edwin B. McCrohan, Jr., M.E. '27, a naval architect and marine consulting engineer, is owner and manager of Edwin B. McCrohan, Jr., Co., 11 Broadway, New York 4, New York.

it takes many engineering skill

McDonnell "Voodoo", *the most powerful jet fighter ever built in America.*



J-57 POWERED AIRCRAFT

MILITARY

F-100	F8U
F-101	A3D
F-102	B-52
F4D	KC-135

COMMERCIAL

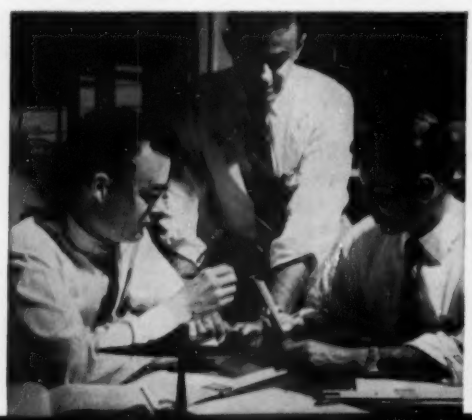
Boeing 707

Douglas DC-8

MECHANICAL ENGINEERS are concerned with many phases including experimental testing and development, mechanical design, stress and vibration analysis, combustion research, heat transfer and nuclear reactor development.

AERONAUTICAL ENGINEERS work on innumerable internal and external airflow problems concerned with design, development and testing of aircraft powerplants. Some who specialize in analytical engineering forecast engine-airplane combinations a decade in advance of design.

ELECTRICAL ENGINEERS directly contribute their specialized skills to the analysis and development of controls, systems and special instrumentation. An example is the "Plottomat" which automatically integrates and plots pressures, temperatures and air angles in performance testing.



to create the top aircraft engines

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that its design and development
require the greatest variety of engineering skills.
Pratt & Whitney Aircraft's engineering team
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the world's best aircraft engines.

The best planes are always designed
around the best engines. Eight of the most
important new military planes are powered by
Pratt & Whitney Aircraft J-57 turbojets.
The first two jet transports in the United States
will use J-57s. Further, no less than
76 percent of the world's commercial air transports
are powered by other Pratt & Whitney Aircraft powerplants.

Such an enviable record can only be built
on a policy which encourages, recognizes and
rewards individual engineering achievement.

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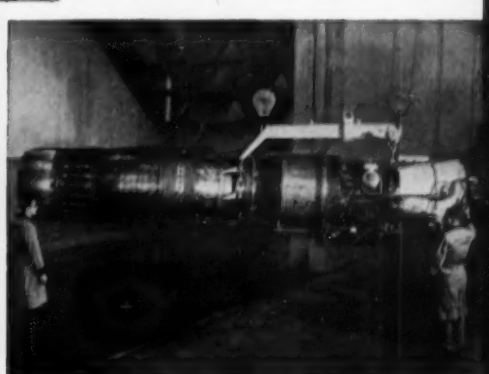
CHEMICAL ENGINEERS, too, play an important role. They investigate the chemical aspects of heat-producing and heat-transferring materials. This includes the determination of phase and equilibrium diagrams and extensive analytical studies.

METALLURGISTS investigate and develop high temperature materials to provide greater strength at elevated temperatures and higher strength-weight ratios. Development of superior materials with greater corrosion resistance is of major importance, especially in nuclear reactors.



WORLD'S MOST POWERFUL production aircraft engine. This J-57 turbojet is in the 10,000-pound thrust class with considerably more power with afterburner.

Meredith Cushing B.E.E. '44, and Leon Wittig, an ice cream manufacturer and retailer in Utica, have formed a new organization, Meredith Wittig Corp., which will operate a chain of retail ice cream stores. The first store had its grand opening in May at 215 Main Street, Binghamton, New York. Cushing, who was formerly with Friendly Ice Cream Co., is president and general manager of the new organization.

Frank L. O'Brien, Jr., M.E. '31, president of The O'Brien Machinery Co., 1545 North Delaware Avenue, Philadelphia 25, Pa., recently spent two weeks in Colombia, where he established a branch office in Bogota at Avenida Jiminez 530, Officina 604.

William Asher Reece M.E. '06, died February 22, 1955, as the result of an automobile accident in Buenos Aires, Argentina, where he lived at Rufino De Elizalde 2848. Before retiring in 1951, he was president and general manager of American Foreign Power Co. in charge of their Argentine subsidary companies.

The election of **Bartholomew J. Viviano M.E. '33, L.L.B. '36,** as vice-president of the Lehigh Valley Railroad was announced, April 27, by **Cedric A. Major '13,** Lehigh Valley president. Viviano will continue to hold the post of general counsel,

—*Alumni News*

B. J. VIVIANO

to which he was named in 1953. An outstanding fullback on the Varsity football team during 1930-32, he was captain during the 1932 season and won all-American honors in 1931-32. From 1941-46, he was a major with US Army Ordnance. His address is 1346 Evergreen Avenue, Plainfield, N. J.

David William Shilling M.E. '12, died April 7, 1955. He was general manager of Elizabeth Motors, Inc., automobile dealers in Elizabeth, N. J., where he lived at 1 DeWitt Road. He was past-president of the Elizabeth Chapter of the Reserve Officers Association and Past- commander of the New Jersey division of the Military Order of Foreign Wars. He was a member of Theta Xi.

Kenneth A. Kesselring B.E.E. '41, has been named new manager of the General Electric Company's Submarine Intermediate Reactor Project which developed the power plant for the submarine Seawolf.

CRESCENT

Insulated Wires and Cables

For more than 70 years CRESCENT Wires & Cables have played a leading role in the growth of the electrical industry. Pictured here are just a few of the many wires and cables made by CRESCENT.

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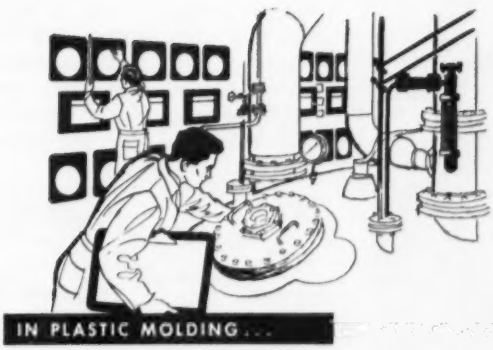
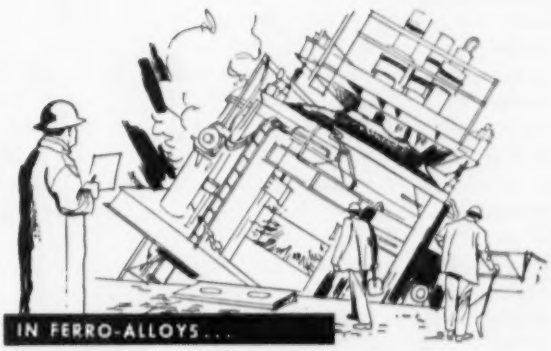
College graduates building a future...
growing with UNION CARBIDE



IN PLASTIC MOLDING...

"After I received my B.S. in Chemistry in 1953, I joined Bakelite Company. Following eight months with an experienced engineer I began independent development work on new thermosetting molding materials. I handle many product problems—from baby bottle caps to guided missile elements—and work closely with sales and production people."



IN FERRO-ALLOYS...

"I'm a metallurgical engineer, Class of '49. I went to work for Electro Metallurgical Company because their training program led directly into supervisory production work. By 1952 I was a Production Engineer. My work has broadened considerably since then, and includes technical control and direct supervision of the production of several tungsten alloys."

IN PETROCHEMICALS...

"Carbide and Carbon Chemicals Company's work with petrochemicals seemed to promise a big future. That's one reason why I joined them, right after I received my Master's degree in chemical engineering, in '54. I was assigned immediately to research and development on the coal hydrogenation process, with specific problems in process design and plant evaluation."

IN PRODUCTION CONTROL...

"I'm a chemical engineer, Class of '50. I started with National Carbon Company as a research assistant in a development lab. In '54 I was promoted to group leader of control engineers, responsible for installing and proving in an automatic furnace for the continuous production of activated carbon. Now I'm in charge of the control lab at one of our plants."

THEY ARE KEY MEN WITH A FUTURE...

If you are interested in a future in production, development, research, engineering, or technical sales, check the opportunities with any Division of Union Carbide. Get in touch with your college placement officer, or write directly to:

UCC DIVISIONS INCLUDE...

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- Union Carbide Nuclear Company

UNION CARBIDE

AND CARBON CORPORATION

UCC

Industrial Relations Department, Room 406
30 East 42nd Street, New York 17, N. Y.

Mr. Kesselring attended Syracuse University two years and was graduated in 1941 from Cornell University with the degree, B.E.E.

During World War II he served with the Army's Ordnance department, working on the development of antiaircraft directors and control units. He later headed a technical intelligence unit in the European Theater. He joined G. E. in January, 1946, and became a member of a group working on the application of atomic power to ship propulsion.

In 1947 Mr. Kesselring was named assistant project manager of the West Milton power breeder reactor project, and in 1951 was named division head of reactor engineering there. In 1953 he was made manager, reactor engineering section.

In 1950 Mr. Kesselring was given the outstanding young electrical engineer award of Eta Kappa Nu honorary group. He is a member of Phi Kappa Phi and Tau Beta Pi honorary fraternities, the American Society of Mechanical Engineers, the Schenectady Curling Club and the G-E Elfun society.

—*Alumni News*

ERWIN W. RIGGS

Edwin W. Riggs M.E. '41, has been appointed Manager Marketing Administration and Personnel Development for the General Electric Company's Schenectady Aeronautic and Ordnance operation.

Mr. Riggs, who was born in Schenectady, was graduated from Cornell University in 1941 with a Bachelor of Science degree in mechanical engineering. He joined General Electric immediately after graduation on the engineering training program, and two years later was assigned to Aeronautic & Ordnance Systems Engineering in Schenectady.

In 1948 he was assigned to Aeronautic & Ordnance Systems marketing with responsibiilty for sales of hydraulic equipment and various bomber armament fire control systems. In 1951, he was transferred to the Dayton, Ohio, office of the Apparatus Sales Division as a sales and engineering specialist in A&OS products, the position he held until his present appointment.

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A Campus-to-Career Case History

Emmett Smith, E.E., '50, supervises operation of the training switchboard which he originally helped to design.

"I Didn't Know There Was Such a Job"

"Communications have always been one of my main interests—in the Navy and at the University of Michigan. So I was very happy when the Michigan Bell Telephone Company invited me to visit their headquarters to talk about a job.

"In Detroit I had a chance to look at a number of departments, including one I'd never heard of before, the Traffic Department. I found that, in addition to the engineering of switchboards, it involved the supervision and handling of calls. *It struck me like a wonderful opportunity to combine staff engineering and field management.*

"My first impression was right, too, because my work covered both. First, I had on-the-job training assignments in several different kinds of offices —local, Long Distance, dial and manual. Then I worked in engineering, translating estimates of future growth into the actual number of circuits and switchboard positions required.

"Now I'm supervising the operation of one of the boards I helped engineer. Briefly my job is to see that my district gets the kind of equipment it needs and that what we have is working properly. Another major part of my job is advising the supervisors of the Long Distance operators. I like this because it means working with people, too.

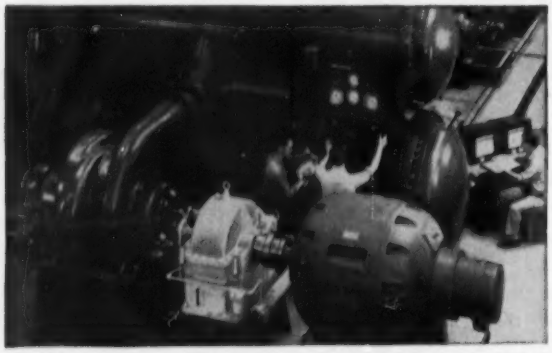
"Needless to say, I'm happy with my job. A job I didn't even know existed."

Emmett Smith's job is with a Bell Telephone Company. There are similar opportunities for engineers with Bell Telephone Laboratories, Western Electric and Sandia Corporation.

BELL TELEPHONE SYSTEM

"POWER OFF!" Test operations are directed from this central control room, where special measuring instruments greatly speed up the collection of pump performance data. That's one way Worthington products are made more reliable by using . . .

. . . the world's most versatile hydraulic proving ground



COMPREHENSIVE TESTS are run on a Worthington centrifugal refrigeration unit (lower left) now in service as one of the Arabian American Oil Company's central air conditioning units in Dhahran, Saudi Arabia.

When you make pumping equipment that has to stand up and deliver year after year anywhere in the world, you've got to be sure it will perform as specified.

That's why we built one of the world's largest hydraulic test stands at our plant in Harrison, New Jersey. Here, over a half-acre "lake," we can check the performance of anything from a fractional horsepower unit to pumps handling over 100,000 gallons a minute. When you realize there are thousands of sizes and types of centrifugal pumps alone, you get an idea of the versatility we had to build into our proving-ground.

Naturally, our new test equipment is a big help to our research engineers, as well as our customers. Now they get performance data on products quickly and accurately. Using it, we can save months, even years, in developing new Worthington fluid and air-handling devices — equipment for which this company has been famous for over a century. For the complete story of how you can fit into the Worthington picture, write F. F. Thompson, Mgr., Personnel & Training, Worthington Corporation, Harrison, N. J.

4.25A

See the Worthington representative when he visits your campus

See the Worthington Corporation exhibit in New York City. A lively, informative display of product developments for industry, business and the home. Park Avenue and 40th Street.

WORTHINGTON

When you're thinking of a good job—think high—think Worthington

AIR CONDITIONING AND REFRIGERATION • COMPRESSORS • CONSTRUCTION EQUIPMENT • ENGINES • DEAERATORS • INDUSTRIAL MIXERS
LIQUID METERS • MECHANICAL POWER TRANSMISSION • PUMPS • STEAM CONDENSERS • STEAM-JET EJECTORS • STEAM TURBINES • WELDING POSITIONERS

New Professors in the Engineering School

DR. DAVID CLARK

Dr. David D. Clark has been appointed to the Cornell engineering physics faculty to supervise the new nuclear power program for undergraduates in the College of Engineering.

DR. DAVID CLARK

Dr. Clark, named assistant professor of engineering physics, will coordinate the program, teach one of its important courses, the nuclear measurements laboratory and do research in reactor and nuclear physics.

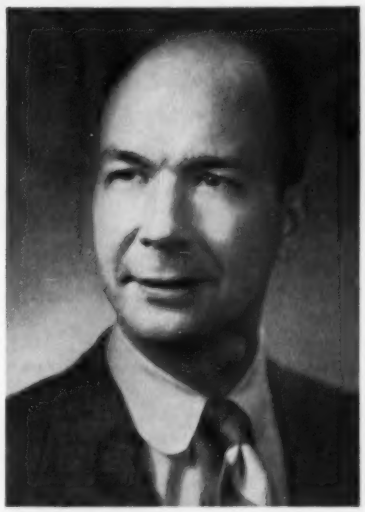
The program is intended to help meet a need for engineers trained in atomic science. It is open to students of any division in Cornell's five-year undergraduate engineering course.

Courses will be given with the help of the Department of Physics, the School of Chemical and Metallurgical Engineering and the School of Mechanical Engineering.

Courses will concern atomic, solid state and nuclear physics; the physics of nuclear reactors; advanced heat transfer and diffusion; properties of reactor materials; radiation damage; radiation-induced corrosion and creep; atomic fuels, fuel processing and waste disposal; and biological effects of radiation.

For the past two years, Professor Clark has been a research associate at Brookhaven National Laboratory in Upton, L. I. Cornell is one of nine eastern universities in Associated Universities, Inc., which administers the center under contract with the Atomic Energy Commission.

Professor Clark graduated from the University of California in 1948 and received his Ph.D. there in 1953. He was a pre-doctoral fellow of the Atomic Energy Commission.



DR. ROBERT FINN

Dr. Robert Finn joins the faculty of the School of Chemical Engineering this year after leaving the University of Illinois, where he did extensive work in setting up a new option in chemical engineering and bio-engineering to deal with microorganisms and biochemical products.

Professor Finn began his studies at Cornell, receiving his B.S. (Chem.) in 1941 and his B.Chem.E. degree in 1942. Following graduation, Dr. Finn went to work for the Merck corporation in New Jersey until, in 1946, he entered the University of Minnesota to take up graduate work in chemical engineering. In 1949 he received his Ph.D. in chemical engineering, and then joined the staff of the University of Illinois, ranking as assistant professor.

At Cornell, Dr. Finn is developing a program in chemical engineering directed to students interested in fermentation and pharmaceuticals, and, in addition to teaching, is occupied with two research contracts, one a study of the effect of mechanical shear on mold tissue, for the American Cancer Society, and the other, under a grant from the U.S. Public Health Service, a study of electrical methods for separating protein compounds in large quantities.

DR. WILLIAM HORTON

The Electrical Engineering School has one new instructor this term, Dr. William Horton.

Professor Horton received his B.S.E.E. from the Massachusetts Institute of Technology in 1943 and soon after, he entered the United States Navy Radar School as an Airborne electronics radar officer. Professor Horton instructed and supervised in airborne electronics equipment maintenance until 1946, when he was discharged from the service.

After leaving the Navy, Dr. Horton continued his studies at Stanford University, where he received the E.E. degree in 1948 and the Ph. D. degree in 1952.

In 1951, Professor Horton began working for the General Electric Company in their General Engineering Laboratory as a project engineer concerned with radar antijamming and studies.

Dr. Horton became associated with the Advanced Electronic Center at Cornell University in

(Continued on page 58)

ADVANCED EDUCATIONAL PROGRAM AT ALLISON HELPS YOU FIND THE BEST JOB SUITED TO YOUR TRAINING

DIVERSITY of technical skills required by Allison in the design, development and production of turbo-jet and turbo-prop engines offers a wide range of opportunities to young graduate engineers.

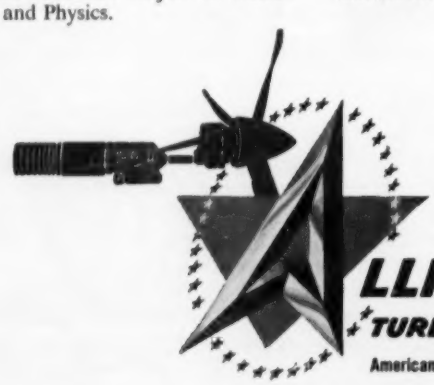
And, the Advanced Educational Facilities help the young graduate find the work best suited to his academic training and liking.

For instance, there's Wayne McIntire (above) Mechanical Engineer, Purdue University, who came to Allison upon graduation in 1950. After completing the training program, Wayne now is doing the kind of work he wanted, and is technically qualified to handle. He is Project Engineer, mechanical design of gea r boxes. He is shown making an adjustment on the propeller linkage control on the cutaway model of the Allison T56 aircraft engine. This, incidentally, is America's first production turbo-prop engine, and is used in the Lockheed C-130 Hercules, a 54-ton transport. The Allison Model 501, which is the commercial version of the military T56, is the powerful turbo-prop engine proposed for commercial airline use.

In his present job, Wayne works on initial design . . . helps decide what components—such as propeller brakes, accessory drives, oil pumps, etc.—are needed for the specific project.

The nature of Allison business continually presents a variety of interesting and challenging problems to the engineering staff, which—along with the Mechanical, Aeronautical, Electrical, Metallurgical, Chemical and Industrial Engineers—includes majors in Mathematics and Physics.

We'll welcome the opportunity of telling you more about the Allison Advanced Educational Facilities, and the benefits and advantages which can be yours at Allison. Arrange for an early interview with our representative when he visits your campus, or write for information about the possibilities of YOUR engineering career at Allison: R. G. GREENWOOD, Engineering College Contact, Allison Division, General Motors Corporation, Indianapolis 6, Ind.



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The Torrington Needle Bearing... many types for many needs

In previous advertisements in this series, the many advantages of the Torrington Needle Bearing and the proper procedure for its installation and maintenance have been discussed. The DC unit type bearing was used in these discussions because it is the Needle Bearing with by far the greatest variety of applications throughout industry.

From the basic Needle Bearing design, however, many modifications have been made. The result is a complete line of Needle Bearings suitable for specific applications. Although these bearings are all different, each offers the advantages which have made the DC unit type so popular. They give the highest possible radial load capacity in a minimum of space; they are light in weight, easy to install and simple to lubricate.

The following chart shows many types of Torrington Needle Bearings, gives their design features and general applications for which they are designed.

The new Torrington Needle Bearing catalog will be sent on request.

TYPE	SERIES	BEARINGS	DESIGN FEATURES	APPLICATIONS
DC	B		Thin, drawn shell, retaining full complement of small diameter rollers. Inner races are furnished when shafts are not hardened.	Wherever high load capacity is needed and space is at a premium.
HEAVY DUTY			The outer race is made in one channel-shaped piece, hardened and ground to precision limits. Heavy inner race.	For heavy-duty applications where split housings occur or where press fit of bearing into housing is not possible.
AIR-CRAFT	NBC		Heavy inner and outer races, with end washers securely fastened to inner race.	Aircraft applications involving oscillating motion only.
	NBE *(left)* NBK *(right)*		Similar to NBC except have self-aligning outer races.	Aircraft applications where alignment is difficult or deflection is severe.
	NBF *(left)* NBL *(right)*		Similar to NBC except have heavy outer races to carry rolling loads.	For use as rollers under heavy loads at low speeds.
CR	CR		Heavy solid-sectioned outer race and rollers made from high-quality bearing steel. Portion of stud which serves as inner race is hardened. Threaded end left soft to avoid brittleness.	Cam follower applications where maximum load capacity and shock resistance are required.

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College News

The Cornell Housing Research Center, under a grant from the Lightolier Corporation, lamp and lighting manufacturers, of Jersey City, N. J., is undertaking a study of home lighting. The aim of the project is to help architects and builders treat lighting as a basic part of the house.

According to Prof. Glen H. Beyer, director of the research center, lighting is pretty much an "afterthought" in many house designs, yet adequate lighting is just as important as a house's appearance and has direct bearing on such factors as comfort, interest and spaciousness. He further stated that lighting has failed to keep pace with other advances in housing design and construction and needs reevaluation to match the tremendous advances evident in the impact of pre-fabricated techniques on current construction.

The Lightolier study will first formulate the basic requirements for good home lighting and then investigate possible engineering and design solutions for these standards. Being considered by the study are such new lighting materials and techniques as luminous panels and ceilings, and advances in wiring and control with special attention being paid to their application in prefabricated dwellings. A final report outlining basic needs and suggested solutions will be made available to architects, builders, and general consumers.

Co-directors of the project are Prof. Everett M. Strong of Cornell's School of Electrical Engineering and Prof. Richard R. Arnold, a designer in the Department of Housing and Design, while other Cornell specialists will be called on for aid on the psychology and aesthetics of home design.

Marshall Lapp Guggenheim Fellowship

Appointment of 14 Daniel and Florence Guggenheim Fellowships to carry on advanced study at three American Universities was announced jointly today by Harry F. Guggenheim, President of the Daniel and Florence Guggenheim Foundation; Dr. Grayson Kirk, President of Columbia University; Dr. L. A. DuBridge, President of California Institute of Technology, and Dr. Harold W. Dodds, President of Princeton University.

The awards are granted annually to outstanding students chosen for their technical ability, leadership qualities, and interest in the fields of air flight structures, rockets and jet propulsion. The Fellowships provide stipends ranging from $1,200 to $2,000 annually, plus tuition, for graduate study at the Daniel and Florence Guggenheim Institute of Air Flight Structures at Columbia, and the two Guggenheim Jet propulsion Centers at Caltech and Princeton. Fellowships are normally awarded for one year, but are renewable for an additional year.

The five new Fellows selected for study during 1955-56 at the Institute of Air Flight Structure at Columbia are: Lt. (j.g.) Euval S. Barrekette, Brooklyn, N. Y.; Stephen J Citron, Yonkers, N. Y.; Michael I. Jarymowycz, the Bronx, N. Y.; B. Walter Rosen, the Bronx, and Gordon P. Smith, Lothian, Md. In addition, Richard P. Shaw, of Queens Village, N. Y., a Guggenheim Fellow in 1954-55, will continue his studies in Columbia's Air Flight Structures program in 1955-56 as a National Science Foundation Fellow.

Marshall Lapp, of Buffalo, N. Y.

—Photo Science

MARSHALL LAPP

attended Cornell University, where he received his Bachelor of Engineering Physics Degree last June. He was a part-time research assistant in Cornell's Graduate School of Aeronautical Engineering and part-time teaching assistant in the Physics Department. Summer employment during Mr. Lapp's collge career includes jobs with Republic Steel Company in 1951, Linde Air Products, 1952; Sylvania Electric Products, 1953, and Cornell Aeronautical Laboratory, Inc., 1954. Previous scholarships awarded to Mr. Lapp include the New York State University Scholarship, New York State Scholarship in Cornell, McMullen Undergraduate Scholarship, Burrell and Kenney Fund Scholarships. He won first place in the Fuertes Memorial Speaking Contest for Engineers in 1954. Mr. Lapp was graduated from Bennett High School, Buffalo, in 1950. His Parents, Mr. and Mrs. Benjamin F. Lapp, live at 2014 Delaware Avenue, Buffalo. His father, a chemical engineer, is Department Supervisor in a Buffalo dyestuffs plant.

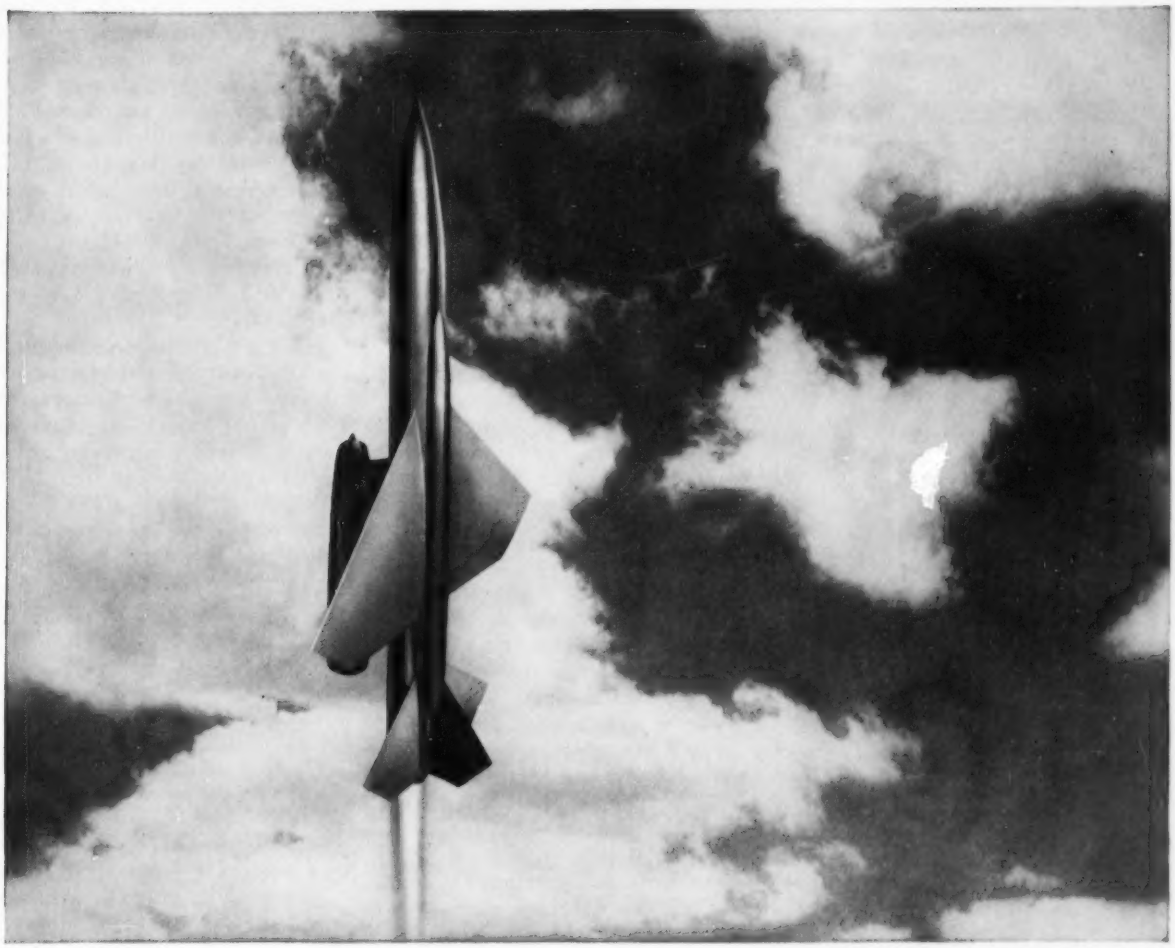
Cornell Aero Labs

Dr. Franklin Kingston Moore has been appointed head of the Aerodynamic Research Department at Cornell Aeronautical Laboratory, Inc., Ira G. Ross, director, announced today.

Dr. Moore, 33, was formerly a consultant to the Supersonic Propeller Division, Lewis Propulsion Laboratory of the National Advisory Committee for Aeronautics, Cleveland, Ohio. He succeeds Alexander H. Flax who was recently appointed assistant director of the Laboratory.

Dr. Moore received the bachelor of science and master of engineering degrees from Cornell University. He was awarded a doctor of philosophy degree in aeronautical engineering from Cornell in 1949. While attending the University he received McMullen scholarships for scholastic achievement and was an instructor for one year in the engineering school.

He was commissioned a first lieutenant in the U. S. Army in World



Boeing engineers have a date with the future

Guided missiles like this Boeing Bomarc IM-99 are increasingly important in America's defense planning. Many kinds of engineers—electrical, mechanical, civil and aeronautical—play vital roles in developing it. The knowledge they are gaining will be priceless in producing the supersonic airplanes and guided missiles of the future. These men explore the frontiers of engineering knowledge in rocket and nuclear propulsion, in extremes of vibration, temperature and pressure and in many other fields.

Boeing engineers are members of aviation's top creative team. The aircraft they help develop will maintain the leadership and prestige established by the Boeing B-47, the present "backbone" of Strategic Air Command . . . the B-52, our giant new global bomber . . . the Bomarc IM-99 . . . and, most recently, the 707 and KC-135, America's first jet transport and tanker.

At Boeing, engineers' professional achievements are recognized by regular merit reviews and in other ways. The Boeing policy is to promote from within the organization. And Boeing is known as an "engineers' company." One out of every seven employees is an engineer! Among top management, the proportion is even higher.

Equipment at Boeing is superb: the latest electronic computers, a chamber that simulates altitudes up to 100,000 feet, splendidly equipped laboratories, and the new multi-million-dollar Flight Test Center. The world's most versatile privately owned wind tunnel, at Boeing, is soon to be supplemented by a new tunnel capable of velocities up to Mach 4.

Do you want a career with one of America's most solidly growing companies? Do you want a chance to grow, and to share in the challenging future of flight? Then plan your career as a member of one of Boeing's engineering teams in design, research or production.

For further Boeing career information consult your Placement Office or write:

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War II and served from 1943 to 1946, part of that time in the Aleutians. He joined N.A.C.A. in 1949 and served for two years as section head in the Special Projects Branch of the Supersonic Propulsion Division.

A theoretical aerodynamicist, Dr. Moore has specialized in boundary layer studies. His publications have included papers in the Journal of Aeronautical Sciences, N.A.C.A. Technical Papers and Reports and Advances in Applied Mechanics. He is a member of Tau Beta Pi, honorary engineering society and the Institute of Aeronautical Sciences. He is married and has four children. He expects to live in Orchard Park, N. Y.

E. E. Scholarship

Cornell's Frank Memorial Scholarships of $500 each, for students in the School of Electrical Engineering, have been awarded to Frank A. Ernandes and James D. Strickler.

The awards are made annually by the Harrison Jules Louis Frank and Leon Harrison Frank Memorial Corporation of Detroit, in memory of the founders of the Bull Dog Electric Products Company.

Mr. Ernandes, entering his final year in the five-year engineering course, received the same prize last year. He is a son of Mr. and Mrs. Salvatore Ernandes of 56-07 201st Street, Bayside, N. Y., and a graduate of Brooklyn Technical High School.

Mr. Strickler, beginning his fourth year in the school, is a son of the Rev. and Mrs. Donald W. Strickler of 20 Lee Avenue, White Plains, N. Y., and a graduate of White Plains High School.

Starting salaries for beginning engineers continue to increase at Illinois Institute of Technology, according to figures compiled by Earl C. Kubicek, director of alumni relations and placement.

They show that the starting pay of the 1955 June engineering graduate with a bachelor of science degree climbed to $381 per month, as compared to the $363 received by the 1954 June graduate.

The figure is a drop from the all-time high of $383 received by the 1955 January engineering class. But, Kubicek pointed out, the differences in the size of classes and other factors account for the invariably higher starting wage received by mid-year grads.

Averages, based on the starting salaries of combined June and January graduating classes at IIT, have increased every year since 1949 when the average was $282 per month, Kubicek said.

In 1950 it jumped to $288; 1951, $295; 1952, $328; 1953, $362; 1954, $368, and 1955, $382.

For the first time, starting salaries of specific categories of engineers topped the $400 mark, with 1955 June electrical engineers receiving $416 and metallurgical engineers received $377 in June, 1954, and $397 in January, 1955.

Here are the beginning salary figures for all categories of IIT engineers:

	June, 1955	January, 1955	June, 1954
Electrical Engineers	$416	$390	$386
Metallurgical Engineers	404	397	377
Civil Engineers	380	378	375
Mechanical Engineers	377	392	373
Industrial Engineers	371	358	356
Chemical Engineers	365	398	362
Architects	353	no grads	365
Fire Protection and Safety Engineers	348	340	338

(Not included in the table is the starting average of $371 for the first three technical drawing graduates from IIT, who received their degrees in June. All three accepted teaching positions at major universities on a nine months per year basis.)

All averages are based on a 40-hour week and apply to engineering graduates with some practical experience, Kubicek said. He explained that nearly all engineering students (all of whom already held fulltime positions), members of the Navy and Air Force Reserve Officers' Training corps program, others who entered immediately into military service, and those who continued on into graduate school.

Members of the June, 1955, engineering class participated in a record 1,233 personal interviews with companies, arranged by the placement office, as compared to 1,089 in June, 1954.

The latest mark, although an all-time high for total interviews, averaged only six interviews per graduate. The figure has run as high as nine per person in past years, Kubicek said.

A Program to increase the strength of the engineer reserve component of the Public Health

(Continued on page 46)

water has many uses

Fortunately, not much water is used like this.

Engineers know that America's greatest natural resource has many other vital uses. Supplying homes and industries with adequate water . . . today and for the future . . . is a job both challenging and rewarding . . . one that merits the talents of America's best young engineers.

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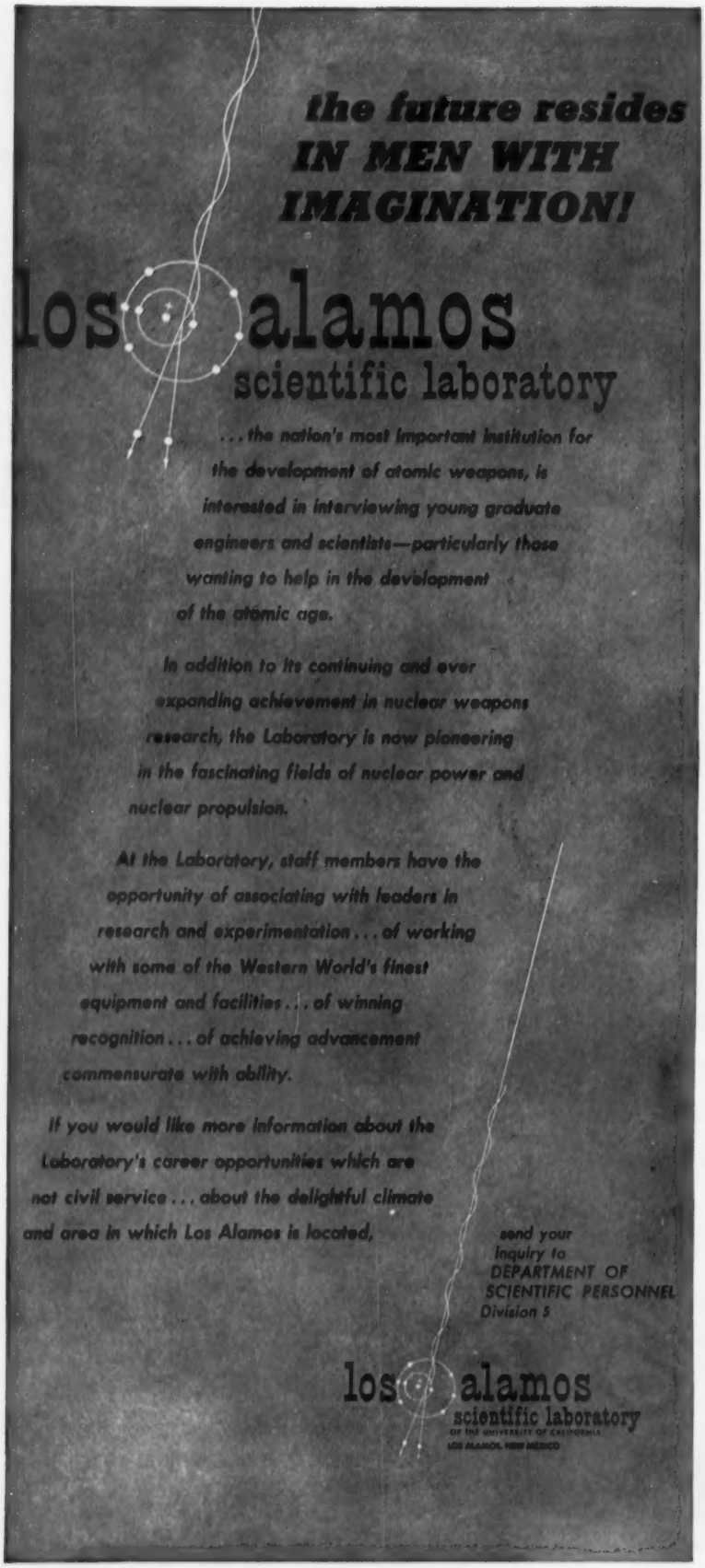
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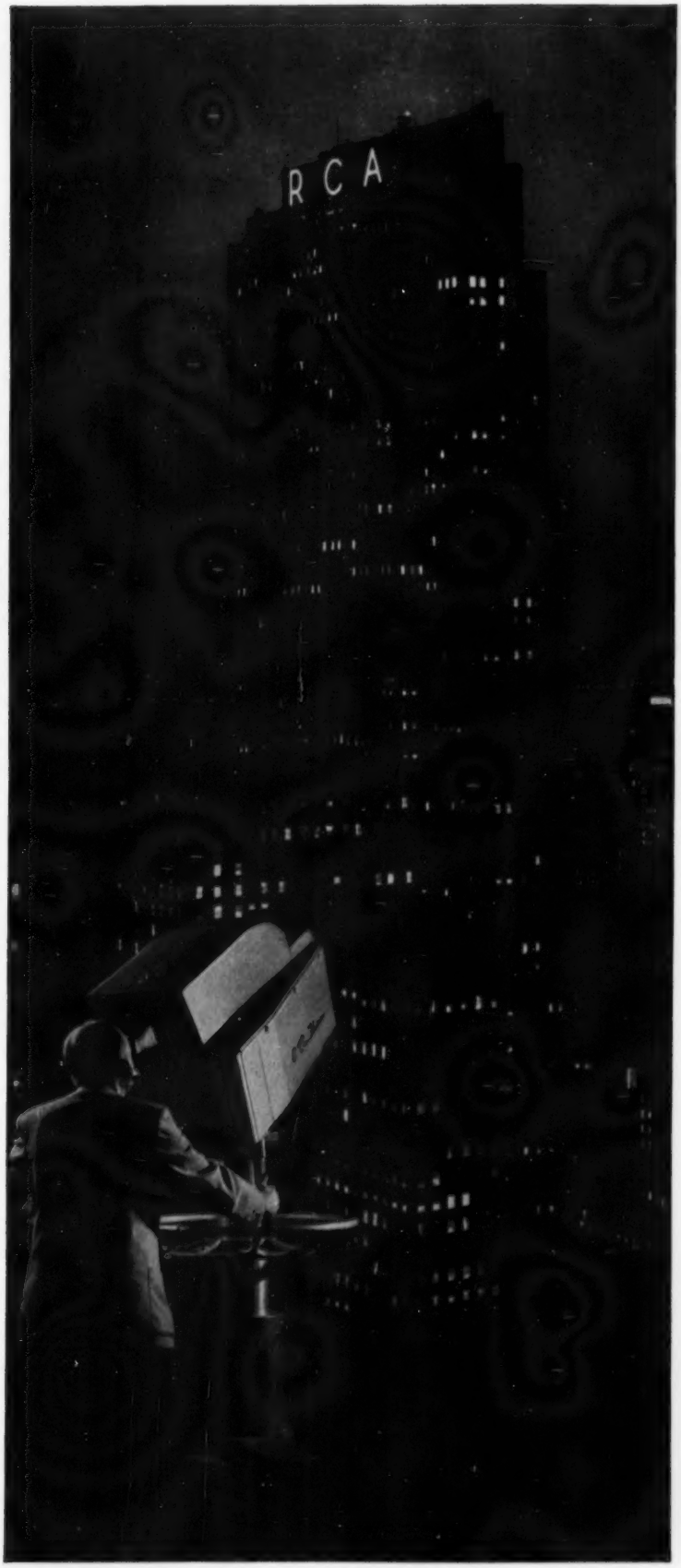
Service, U. S. Department of Health, Education, and Welfare, is now getting under way, according to Assistant Surgeon General Mark D. Hollis, Chief Engineer of the Service. This is in line with a recent announcement by Surgeon General Leonard A. Scheele calling for the commissioning of 2,000 additional reserve officers, including engineers, in order to prepare for possible civil defense health emergencies. These trained sanitary engineers would be needed in case of war to remobilize the facilities upon which the public health of urban populations depend.

Benefits accrued to the PHS engineer reservist, are the receipt of the quarterly *Sanitary Engineering News Letter*, copies of selected new technical publications, bulletins, and other releases of interest, access to the various facilities of the service, including the Robert A. Taft Sanitary Engineering Center in Cincinnati, Ohio, and the availability of such training courses as nuclear fission principles and the handling of radiological monitoring instruments.

TheTechnical Panel on Ionospheric Physics of the U. S. National Committee for the International Geophysical Year 1957 has been formed with nine prominent scientists from various parts of the country. The immediate project of the committee will be to start the operation of thirteen additional ionospheric observatories at necessary points around the world before 1957. That year, thirty-eight nations will coordinate research on some of the world's great scientific mysteries in the hope that a series of observations may bring solutions to problems that have long baffled individual efforts by scientists.

Dr. Millet G. Morgan, of Dartmouth College, has been selected chairman of the committee, which includes H. G. Booker of Cornell. Dr. Morgan explained that the job of the committee during 1957 will be to make a study of the upper ionosphere through the combined efforts of radio engineers, physicists, and astronomers with the aim of better understanding it and being able to predict its activity in the same manner as is now possible in the lower ionosphere.

(Continued on page 58)



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RCA's 36 years' experience is yours to share in TV—black-and-white or color

To pioneer and develop television, in color as well as in black-and-white, called for a special combination of practical experience, great resources and research facilities in the fields of communications and electronics.

RCA was well qualified to do the job:

EXPERIENCE: RCA has been the recognized leader in radio communications since its formation thirty-six years ago. Its world-wide wireless circuits, established in 1919, and its development of electron tubes, laid the groundwork for radio broadcasting in 1920 . . . and the first nationwide radio network in 1926.

Radio broadcasting led to television—and in 1939 RCA made history by introducing black-and-white TV as a service to the public.

Dr. V. K. Zworykin of RCA invented the Iconoscope, or television camera tube, and he developed the Kinescope, now universally used as the picture tube.

RESOURCES: Pioneering and development of color TV has been one of the most challenging and expensive projects ever undertaken by private industry. To date, RCA has spent $50,000,000 on color TV research and development, in addition to the $50,000,000 previously spent in getting black-and-white TV "off the ground" and into service.

RESEARCH FACILITIES: RCA has one of the most complete, up-to-date laboratories in the world—the David Sarnoff Research Center at Princeton, N. J. It is the birthplace of compatible color television and many other notable electronic developments.

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RCA offers careers in research, development, design, and manufacturing for engineers with Bachelor or advanced degrees in E.E., M.E. or Physics. For full information, write to: Mr. Robert Haklisch, Manager, College Relations, Radio Corporation of America, Camden 2, N. J.

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U. S. Fish and Wildlife Service Employs Television In Underwater Research

An underwater application of RCA closed-circuit television which is enabling the U. S. Fish and Wildlife Service, Department of the Interior, to observe and test the performance of experimental fishery methods and equipment under actual oceanic conditions has been reported by Theodore A. Smith, Vice-Presidenta nd General Manager, Engineering Products Division, Radio Corporation of America.

The application represents the first practical demonstration in this country of underwater television as a research tool for experimental work in fishery operations, and gives promise of a wide range of uses in marine biology and explorations, according to Reider F. Sand, Chief of the Fish and Wildlife Service's Gear Research and Development Program.

Currently, the Service is utilizing closedcircuit television in connection with the development of a midwater trawling net and in a remote study of shrimp in their natural habitat, he said.

The Service's underwater TV experiments were initiated with "Operation Fisheye," conducted recently in the Gulf Stream off the east Florida coast, Mr. Smith pointed out. A standard RCA ITV closed-circuit television system provided remote observations of experimental fishery gear towed at depths of more than 60 feet. The gear was illuminated only by natural sunlight, and the views produced on the TV monitor were sufficiently clear and sharp for photographing by both still and motion picture cameras.

"Research in the field of fishery methods and equipment has been hampered by the limited access to direct observations of fishing gear in operation," Mr. Sand explained. "Advances in the design and construction of nets, trawls, and other devices have resulted largely from trial and error, scanty information obtained from work with models, or information supplied by divers working with underwater film cameras. The advent of underwater TV research in other fields, indicating the possibilities of closed-circuit TV as a means for securing direct observation of fishing gear and methods, led to the assignment of such a project to the Service's Exploratory and Gear Development Station at Coral Gables, Florida."

In underwater operations, the RCA ITV camera is housed within a watertight steel cylinder, devised by technicians of the Fish and Wildlife Service, which is mounted in a submersible free-flooded, ball-type "diving bell." Atop the "diving bell," and connected to it by a gear train and yoke assembly, is a watertight electrically driven power unit, which permits remote control of the TV camera's scan—360 degrees in azimuth and 90 degrees in elevation. What the TV camera "sees" is projected over a flexible multiconductor cable to a remote control TV monitor aboard the Service's research vessel, the USS Pompano.

"Such a system," Mr. Sand said, "can conceivably be operated at much greater depths than a diver can withstand and for much longer periods of time without the risk attendant to a diver operating an ordinary underwater film camera.

"The value of underwater television as an aid to investigations in marine biology and in limnology has been demonstrated in these operations," he continued. "In addition to gear research in the commercial fisheries, it may prove to be of assistance in the delineation and harvesting of clam, oyster, and scallop beds. Closer views might also be obtained of bottom formations, bottom-type fishes, and fishes in their natural habitat, which at present may be located only with difficulty by depth-sounding equipment. Further, underwater TV offers possibilities of direct monitoring of water temperatures, current flows, turbidity, and other oceanographic data related to the fisheries."

—RCA

Closed Circuit Underwater Television Camera.

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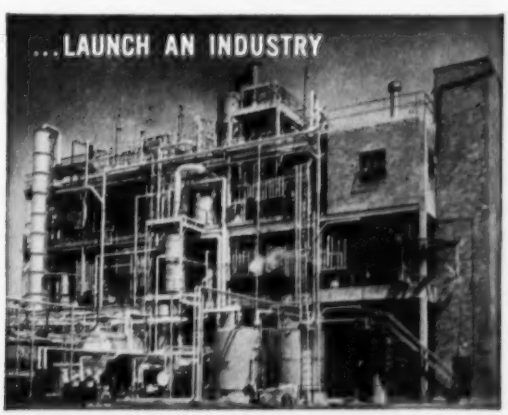
EXCITING NEW DISHES AND CUTLERY, both molded with a new Hercules plastic, Hercocel® W, are as durable as they are beautiful. A product of Hercules research, Hercocel W is a low-cost thermoplastic combining high heat resistance and good dimensional stability with exceptional toughness and impact strength. (Tranquil ware dishes by Byrd Plastics, Inc.; cutlery by Royal Brand Cutlery Company, a Division of National Silver Company, Brooklyn, New York.)

HANDY CONTAINERS and display rack for Hercules smokeless powders work two ways—they make it easier for the sportsmen who do their own loading to select the right powder, and convenient for the dealer to arrange an eye-catching display. Hercules powders have long been the favorite with handloaders who want accuracy and economy.



A MILLION POUND A MONTH PLANT is now producing dimethyl terephthalate at Burlington, N. J. Largest single user: Canadian Industries (1954) Ltd., in the synthetic fiber 'Terylene'. Hercules' plant, first to make DMT by air oxidation, is designed to expand as markets grow.

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G55-9

HERCULES

CHEMICAL MATERIALS FOR INDUSTRY

Westinghouse Cold Chamber

A new low-temperature chamber, believed to be the first of its kind to use helium as a refrigerant to attain temperatures as low as minus 452 degrees Fahrenheit for purposes of tension testing, has been developed by the Westinghouse Electric Corporation.

Metal is stressed to provide information regarding the types of metals that are best suited for use under extreme temperature ranges, as in guided missiles and other supersonic aircraft. Data is needed, for instance, on which metals should be used as storage tanks for low temperature liquid fuels and coolants if these ever prove practicable for guided missiles. Oxygen for human consumption during high altitude aircraft operation is already being stored in liquid form in metal containers at temperatures of about 300 degrees. This arrangement is more practical than using compressed gas since an equivalent size storage space contains a much larger supply of oxygen in liquid form.

Tests made in the chamber may also contribute to man's understanding of the behavior of metals. Since the new testing temperature is within 7.6 degrees Fahrenheit of absolute zero, the tests may help to establish a better understanding, for instance, of the strength of metals and the factors that cause embrittlement failures, such as occur when normal grades of steel are subjected to extremely low temperatures.

When a metal is to be tested, a sample about one inch long and one-quarter inch in diameter is placed inside the special vacuum insulated chamber, which is only slightly larger than a hand fire extinguisher. Liquid nitrogen is used for the initial cooling of the chamber from room temperature to minus 320 degrees. At this point liquid helium is introduced to take the temperature down to minus 452 degrees. Nitrogen is used in the room temperature to minus 320-degree range because it is considerably more economical and efficient than is the use of helium at these temperatures.

When the chamber and test sample are stabilized at the desired temperature, a tension load is applied to the sample and is gradually increased until the piece of metal breaks. During the test the temperature of the metal specimen and also the stress-strain readings from the sample are recorded electrically on graphic charts. In current experiments, the maximum stress that can be applied to the sample is 260,000 pounds per square inch.

AGE and Lockheed Computers

New electronic computers were installed earlier this year by two more business organizations, the American Gas and Electric System (AGE) and the Lockheed Aircraft Corporation.

A giant analog computer was put into service in the Columbus, Ohio, headquarters of AGE to facilitate calculations of the most economical means of generating and transmitting electric power through about 8,400 miles of high voltage lines.

Suede Jackets

A suede jacket is no longer strictly a luxury item—not if it's a **Bantamac Lava Leather*** jacket! *Lava Leather is a new discovery—a **completely** washable suede-made for long, hardy wearability.

Trimmed with 100% Nylon knitted collar, cuffs and waistband, this zippered jacket is available in four shades:

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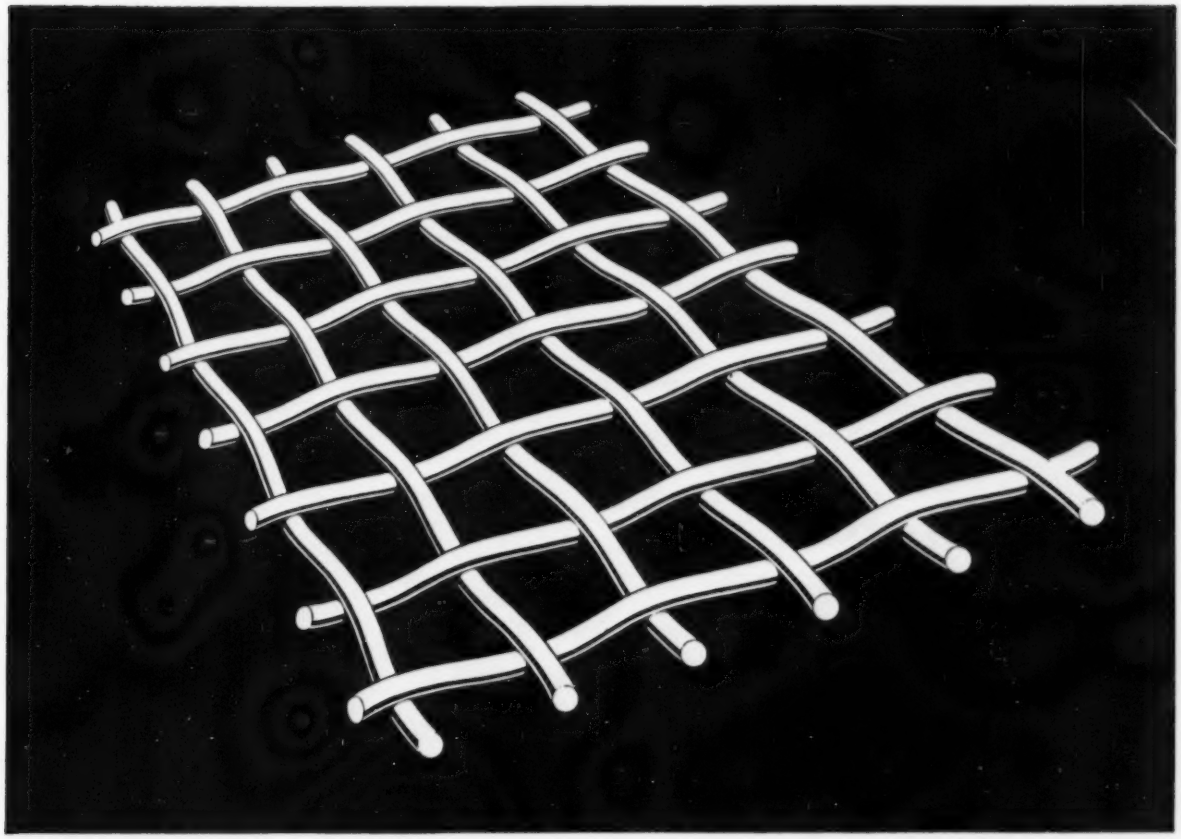

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Between these extremes, the great variety of weaves, weights, meshes and metals makes possible 10,000 different specifications for screens designed to withstand abrasion, chemical corrosion and wide ranges in temperature.

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To a few 1956 engineering graduates, "McGraw-Hill" will mean "writing" as well as "reading."

If you are interested in becoming an engineering editor, write our Personnel Relations Department—now—about your qualifications for an editorial career.

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PUBLISHING COMPANY, INC.

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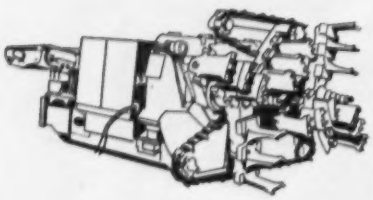
HEADQUARTERS FOR TECHNICAL AND BUSINESS INFORMATION

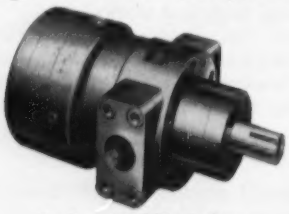
Cuts and loads 7 tons of coal in 1 minute



with **DENISON** hydraulic equipment

WHEN THIS continuous mining machine bores into a bed of coal, things begin to happen. It cuts and loads seven tons of coal per minute from solid seam. One essential requirement for machinery like this is compact, rugged control equipment.

On this mining machine, Denison hydraulic pumps, motors and valves provide finger-tip control for tramming, for moving the conveyor chain and for tilting, retraction and conveyor swing.



Denison Axial Piston Pump

Denison hydraulic pumps, motors and controls are found on many types of equipment from mining machines to guided missiles. We'll be glad to send you more information about Denison hydraulic equipment. Write us.

THE DENISON ENGINEERING COMPANY
1218 Dublin Road • Columbus 16, Ohio
Leading Designer and Manufacturer of Hydraulic Presses and Components

DENISON Hydr OIL ics

AGE and General Electric co-operated in the design of the device, which is expected to save AGE up to $100,000 annually by instant computation of power losses between points of generation and points of use.

Called a transmission penalty factor computer, it is an analog of the loss coefficients of the actual system, expressing mathematically the system's major load centers, inter-connections with other systems, the amount of electricity being generated at different plants, and the distribution of users in AGE's 46,000-square-mile service area.

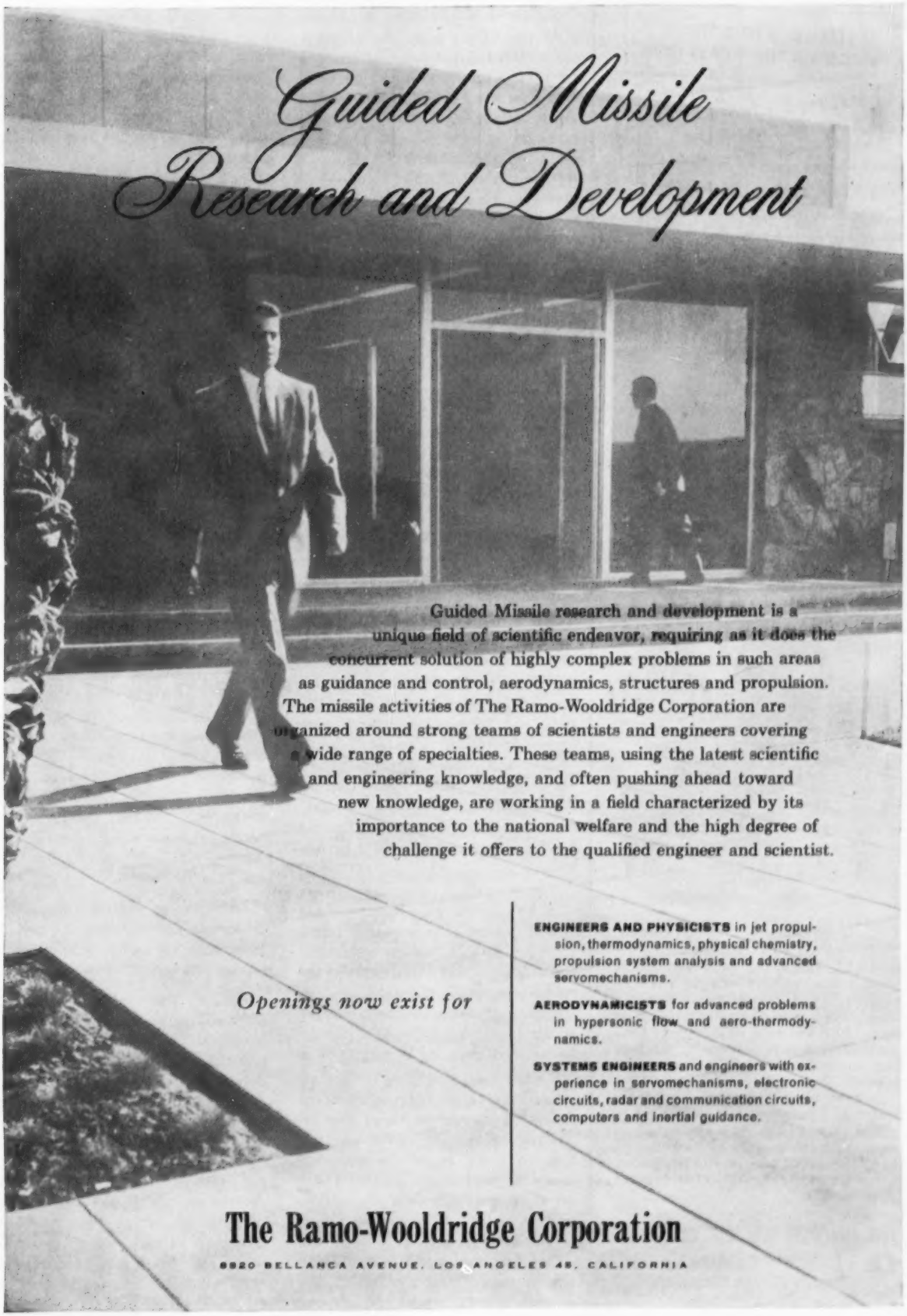
An IBM Type 650 Magnetic Drum Calculator has been installed at the Georgia Division factory of Lockheed at Marietta, where it will be used to solve aerodynamic, stress, and flutter problems. The major new feature of this 1955 model calculator is a larger "memory," consisting of a magnetic drum four inches in diameter and 16 inches long. Each of as many as 20,000 digits can be recorded on the surface of the drum as a tiny magnetized spot.

The first mass spectrometer to be used in the steel industry is now in operation at U. S. Steel's Applied Research Laboratory where it qualitatively and quantitatively analyses complex mixtures of organic compounds, in the form of vapors or volatile liquids, more accurately and more quickly than the infrared or ultraviolet light spectrometers.

In the mass spectrometer, molecules of a compound are smashed into ionized fragments by electron bombardment. The number of ionized fragments of each mass is measured, and from this data the types and amounts of different organic compounds in a gas or vapor mixture can be determined.

A sample of gas is caused to "leak" into the analyzer in a molecular stream. The molecules are bombarded by electrons, and the resulting charged particles are separated into groups according to the ratio of mass to charge. This separation is effected by accelerating the fragments into a strong magnetic field which can control the path of the charged particles and

U. S. Steel Mass Spectrometer.


Guided Missile
Research and Development
Guided Missile research and development is a unique field of scientific endeavor, requiring as it does the concurrent solution of highly complex problems in such areas as guidance and control, aerodynamics, structures and propulsion. The missile activities of The Ramo-Wooldridge Corporation are organized around strong teams of scientists and engineers covering a wide range of specialties. These teams, using the latest scientific and engineering knowledge, and often pushing ahead toward new knowledge, are working in a field characterized by its importance to the national welfare and the high degree of challenge it offers to the qualified engineer and scientist.
Openings now exist for
ENGINEERS AND PHYSICISTS in jet propulsion, thermodynamics, physical chemistry, propulsion system analysis and advanced servomechanisms.
AERODYNAMICISTS for advanced problems in hypersonic flow and aero-thermodynamics.
SYSTEMS ENGINEERS and engineers with experience in servomechanisms, electronic circuits, radar and communication circuits, computers and inertial guidance.
The Ramo-Wooldridge Corporation
8820 BELLANCA AVENUE, LOS ANGELES 45, CALIFORNIA

STEEL IS 2 TO 3 TIMES STRONGER THAN CAST IRON

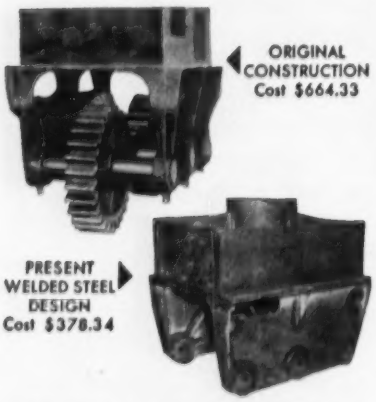
STEEL IS 2½ TIMES AS RIGID AS CAST IRON

STEEL COSTS ⅓ AS MUCH PER POUND AS CAST IRON

thoughts to think about

FIGURE the facts yourself. Only 40% as many pounds of metal are needed to build a machine part from steel as from cast iron. Furthermore, each pound of steel costs a third as much as iron. As a result, basic material costs using steel are about 15% of the costs using cast iron.

The large initial saving in material cost makes it possible to fabricate machine designs from steel at substantial reductions in cost.



Compare the two gear cases shown. The original cast construction cost $664.33. Changing to welded steel design has cut this cost to $378.34 . . . a 43% reduction in cost. In addition, scrap loss from metal defects has been entirely eliminated. Less material has to be left on for machining since distortion has been minimized.

According to leading product engineers, low manufacturing costs are of prime importance. As a student engineer, therefore, it will pay you to keep abreast of progress in designing for welded steel. Write for further information.

THE LINCOLN ELECTRIC COMPANY
Cleveland 17, Ohio
The World's Largest Manufacturer of Arc Welding Equipment

direct them to a target.

At the target plate the charged particles lose their positive charges by taking up electrons. This electron flow is amplified and activates a pen on a moving chart. For mixtures of substances, the resulting graph on the chart is a composite representation of all compounds present. This composite picture, through mathematical treatment, yields quantitative and qualitative data on the mixture.

ASME Compiles Standard Definitions

In an answer to the emphatic demands for standardization of management's jargon, the American Society of Mechanical Engineers announced the publication of the long-awaited standard on "Industrial Engineering Terminology."

The project was begun in the ASME Management's Work Standardization Committee and was spurred on by the International Committee on Scientific Management (CIOS) and the Ninth International Management Congress.

Definitions were drawn up by practicing management consultants and terminology committees from Australia, Canada, South Africa and Great Britain. They were then assembled and edited by the Work Standardization Committee prior to final approval by the ASME Board of Codes and Standards.

Result of these paintaking efforts is a handy 50 page compendium of 500 industrial engineering terms arranged in alphabetical order and running from the initial entry, "abnormal reading" through "written standard practice." Definitions are as brief as practicable and can be understood even by non-experts in the field.

Subjects range from elementary definitions, such as those for industrial engineering of for a standard itself, to an entire series of complex production terms. There are concise descriptions of the flow process chart and the simo chart, of the Gantt chart as well as the Gantt task and bonus plan, of job classification and evaluation, of process layout and work station.

The soiling of home and industrial furnishings by airborne dust lem confronting the housewife and maintenance man, can now be reduced by the treatment of a collodal silica, "Ludox," a product of Du Pont's Grasselli Chemicals Department.

Through the use of the electron microscope and other research instruments it was discovered that every surface is peppered with tiny pits and crevices into which microscopic particles of dirt and dust settle. Once imbedded in these imperfections, they successfully resist removal by vacuum cleaner or carpet sweeper.

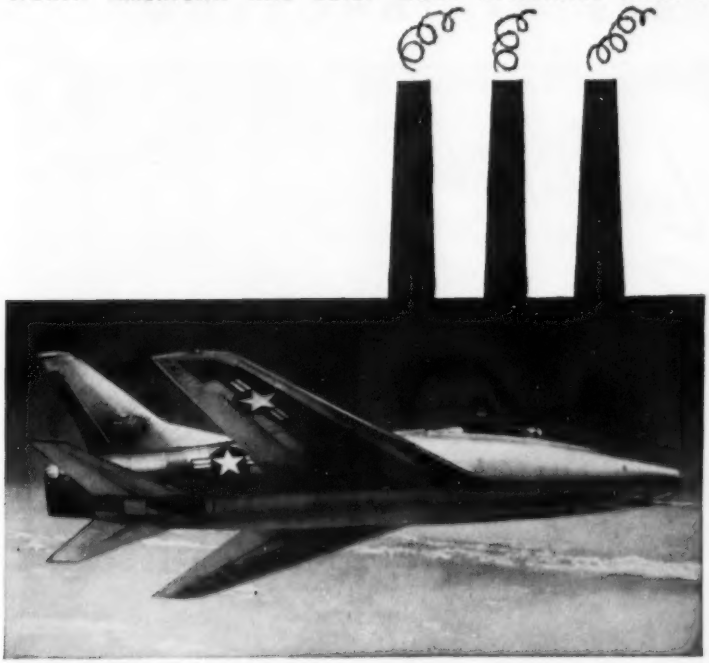
The soil retardent action of "Ludox" is a result or its remarkable physical properties. "Ludox," a liquid dispersion of extremely fine particled material, is colorless, odorless, non-inflammable, and safe for home use. It is made from sodium silicate, which in turn is derived from sand, but there is no similarity between the coarse, jagged crystals of sand and the microscopically small, perfectly round particles of "Ludox" collodal silica.

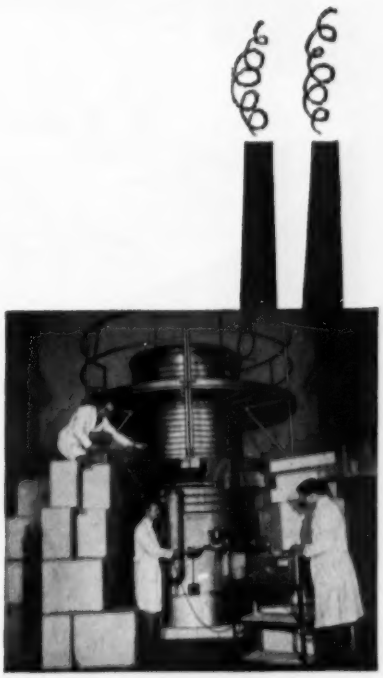
Each particle of "Ludox" is about 17 millimicrons in diameter, or less than a millionth of an inch. This means that it would take about 600 million such particles to cover the head of a pin. As another comparison, if a basketball were enlarged to the size of the earth, then a particle of "Ludox" enlarged in the same ratio would be only the size of a tennis ball.

Since the minimum soil particle diameters are between 20 and 50 millimicrons, "Ludox" can enter into any site receptive to soil.

Liquid formulations may be sprayed or brushed onto new or freshly cleaned surfaces, such as painted walls, wallpaper, rugs, upholstery fabrics, lamp shades, etc. The tiny "Ludox" particles settle into the soil receptor sites. As their liquid carrier evaporates, these particles coalese, or gel together, filling the crevices and leaving a smooth surface on which dirt can find no place to go. Home cleaning methods, such as vacuuming, do not remove the "Ludox." It remains on the treated surface to give continued protection.

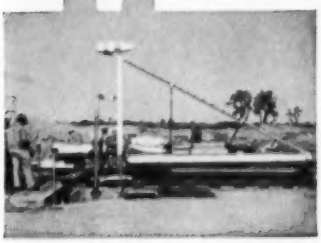
NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD





At North American—

DIVERSITY CREATES OPPORTUNITY



Graduates, undergraduates—A North American representative will be on your campus soon. He will give you complete details on the hundreds of openings these expanding fields create: AIRCRAFT: the Korea-famed F-86 SABRE JET, the record-smashing F-100 SUPER SABRE, and Airborne Vehicles of the Future. GUIDED MISSILES: the SM-64 NAVAHO Intercontinental Guided Missile. ELECTRO-MECHANICAL CONTROLS: fire controls, automatic navigation systems, flight control computers—for aircraft and missiles. ENGINES: lightweight, high-thrust rocket engines for the NAVAHO and for other missile programs. ATOMIC ENERGY: the development of nuclear reactors for research, medicine and power.

North American engineers work in top-level teams, share in a liberal Patent Award Program, a highly successful Suggestion Award Plan and many other unexcelled job benefits.

See the North American Representative at your school... or write:

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Engineer Personnel Office
North American Aviation
Los Angeles 45, California

Mr. Kimbark, Dept. 9120-CM
Engineer Personnel Office
North American's Missile & Control Departments
Downey, California

Mr. Pappin, Dept. 56-CM
Engineer Personnel Office
North American's Columbus Division
Columbus 16, Ohio

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The company that launches this wonder will probably look to New Departure for ball bearings. For New Departures have proved their ability to hold moving parts in perfect alignment, cut wear and friction, and work long hours without letup—or upkeep. Above all, New Departure has lived up to its name—being *first* with ball bearing advancements.

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You'll get better buys, better service with the widespread and growing use of IBM techniques in manufacturing, distribution, retailing.

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IBM ®

World's largest producer of electronic data processing machines, electric typewriters, and electronic time equipment.

Faculty . . .

(Continued from page 39)

1953 when he bacame a supervisor in the field of radar anti-jamming and electronic countermeasure techniques.

Professor Horton is presently teaching a course in pulse techniques in communications and radar.

DR. GEORGE SMITH

Dr. George Smith, the only addition to the Metallurgical division of the Chemical and Metallurgical Engineering school staff this term, will be instructing courses in the properties of metals at high temperatures.

Professor Smith was appointed this year to the Francis Norwood Bard Professorship of Metallurgical Engineering in the School of Chemical and Metallurgical Engineering. He has been a research metallurgist with the U. S. Steel laboratory at Kearney, N. J.

Professor Smith took his undergraduate training at the Carnegie Institute of Technology, in Pittsburgh, Pennsylvania. After receiving his B.S.Met.E. degree from Carnegie Tech. in 1947, Dr. Smith went on to receive his Doctor of Science degree in 1941. In 1948, he started teaching evening graduate courses in the graduate school of the Polytechnic Institute of Brooklyn.

Dr. Smith is the author of a number of technical publications and a textbook on the subject of properties and behavior of metals at high temperatures. In addition to his literary sideline, Professor Smith is a member of a number of national technical committees, such as the Joint A.S.M.E.—A.S.T.M. Committee on the Effect of Temperature on the Properties of Metals, the Pressure Vessel Research Committee of the Welding Research Council, and the Publication Committee for the American Society for Metals.

College News . . .

(Continued from page 46)

1955 Baker Lecturer in Chemistry

Paul Emmett, professor of chemistry at the Johns Hopkins University and an authority in the field of catalysis, has been named 1955 Baker Lecturer in Chemistry at Cornell.

Between November 8 and December 15, Dr. Emmett will lecture on "Current Ideas on Contact Catalysis" at 11 a.m. each Tuesday and Thursday in room 107 of Baker Laboratory.

Dr. Emmett is editor for a series of lectures on "Catalysis" being published by the Reinhold Publishing Company. The series of seven volumes, a comprehensive critical resume of all that is known in the field, are written by experts from this country and abroad.

He has lectured on catalysis in the graduate schools at George Washington University, Johns Hopkins and the University of Pittsburgh. He has written approximately 100 publications in the field of adsorption and catalysis.

Dr. Emmett devoted 11 years to the study of iron catalysts at the Fixed Nitrogen Research Laboratory in Washington, D. C. He spent six years in the department of chemical engineering at Johns Hopkins doing research in the field of adsorption on carbon black, charcoal, porous glass, chabazite and other materials.

For 10 years, he was at the Mellon Institute in Pittsburgh, mainly concerned with the catalytic processes of interest to the petroleum industry.

The Baker Lectureship was endowed in 1919 by the late George F. Baker, banker, philanthropist and former Cornell trustee. Mr. Baker also gave Cornell funds for Baker Laboratory and Baker Dormitory.

Prof. C. L. Cottrell Elected Fellow

Prof. C. L. Cottrell of the School of Electrical Engineering at Cornell University has been elected a fellow of the Illuminating Engineering Society. The Society announced the election of "12 distinguished members" to the honor.

Under sponsorship of the I.E.S. Research Fund Professor Cottrell developed a "contrast brightness threshold meter" which is widely used in measuring visibility. He has been responsible for many developments in brightness and its measurement, optics, fatigue and vision, and in color.

His original appointment at Cornell was in 1920. He was associated for a time with the National Bureau of Standards and with the Munsell Color Company.

OFFICERS OF SCHOOL SOCITIES

American Institute of Civil Engineers

President—Douglas Merkle
Vice-President—Henry Shing Yi Ma
Secretary—Harry Halac
Treasurer—Bryce Rittenhouse

• • •

American Institute of Chemical Engineers

President—James Alexander
Vice-President—Phillip Grosso
Secretary—Richard Oswald
Treasurer—Lee Chamberlain

• • •

American Institute of Mechanical Engineers

President—John Johnson
Vice-President—Alan Spindler
Sec.-Treas.—Souren Hanessian

• • •

Engineering Physics Society

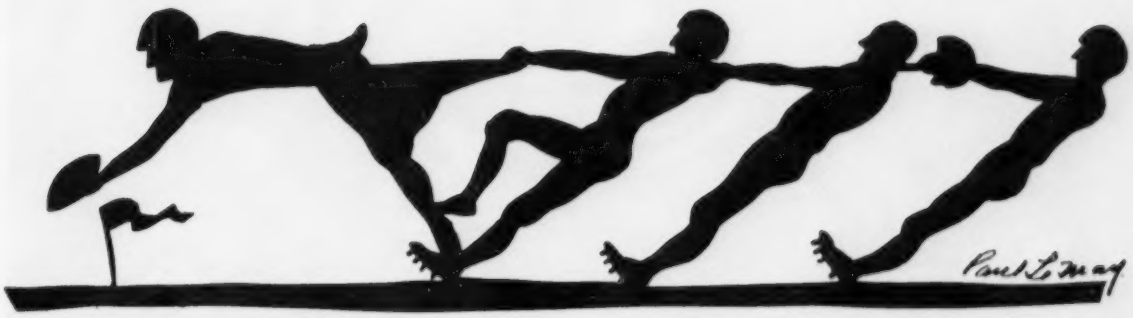
President—Jack Erickson
Vice-President—John Ahearne
Sec.-Treas.—Marilyn Ofelt

• • •

American Institute of Electrical Engineers
Institute of Radio Engineers (combined)

President—Russell Laidlaw
Vice-President—Robert Gale
A.I.E.E. Secretary—George Durland
I.R.E. Secretary—William Hudson, Jr.
Treasurer—Neale Van Delft

Determine NOW To Reach Your Goal



The choice of your career association means much to you in realizing your ambition. CONVAIR-FORT WORTH offers exceptionally attractive career opportunities worthy of investigation and consideration by every Engineering Graduate.

As a division of General Dynamics Corporation, CONVAIR of Fort Worth occupies an important place in the long-range development of the Nation's military and commercial aviation. CONVAIR'S scope of activity offers interesting career opportunities for men with engineering talents.

At CONVAIR-FORT WORTH you work in ideal, air-conditioned surroundings. A company-sponsored, in-plant program enables candidates to earn graduate degrees in Engineering. CONVAIR has paid vacations, excellent insurance and retirement programs. Advancement is entirely on merit.

Fort Worth in the Great Southwest has an abundance of community life of interest to college graduates — Southwest Conference athletics, excellent musical and theatrical bookings, seven large lakes in nearby area, year-around climate conducive to outdoor living and recreation.

Write now for information about CONVAIR'S interest in Engineering Graduates.

Address . . . H. A. BODLEY
CONVAIR Engineering Personnel Dept.
Fort Worth, Texas

CONVAIR

A DIVISION OF GENERAL DYNAMICS CORPORATION

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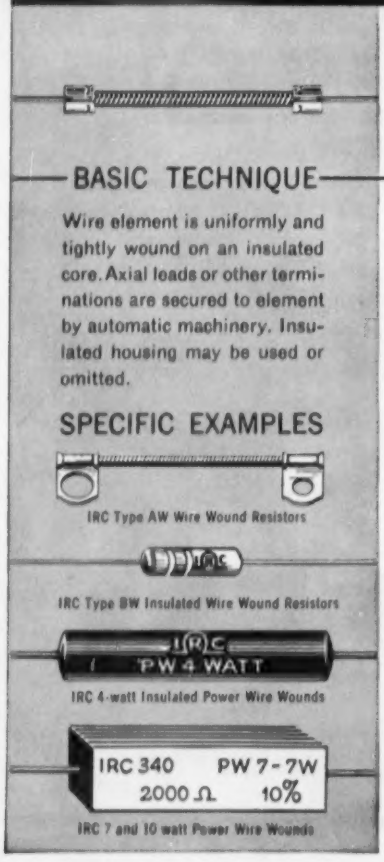
An enlarged reprint of the above cut-out silhouette, suitable for framing or pinning up, will be sent free to any engineering student on request.

Precision, high-speed winding equipment for IRC elements


BASIC TECHNIQUE
Wire element is uniformly and tightly wound on an insulated core. Axial leads or other terminations are secured to element by automatic machinery. Insulated housing may be used or omitted.
SPECIFIC EXAMPLES
IRC Type AW Wire Wound Resistors
IRC Type BW Insulated Wire Wound Resistors
IRC PW 4 WATT
IRC 4-watt Insulated Power Wire Wounds
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2000 Ω 10%
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NOTICE

TO PHOTOGRAPHERS

▼

The CORNELL ENGINEER announces the purchase of a new Crown Graphic Camera & Equipment for use by the illustrations board.

▼

Students experienced or interested in photographic work (but lacking equipment) are invited to contact the ENGINEER for information on Illustrations Board competition!

▼

We have several openings

are you sure

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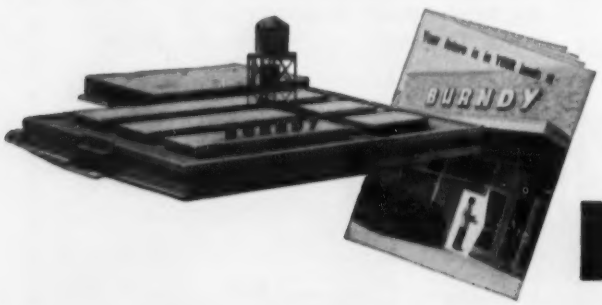

For this 16-page, color booklet, YOUR FUTURE IS IN YOUR HANDS AT BURNDY — information that may lead to the most profitable time of your life . . . write W. F. Bonwitt, Chief Administrative Engineer

BURNDY

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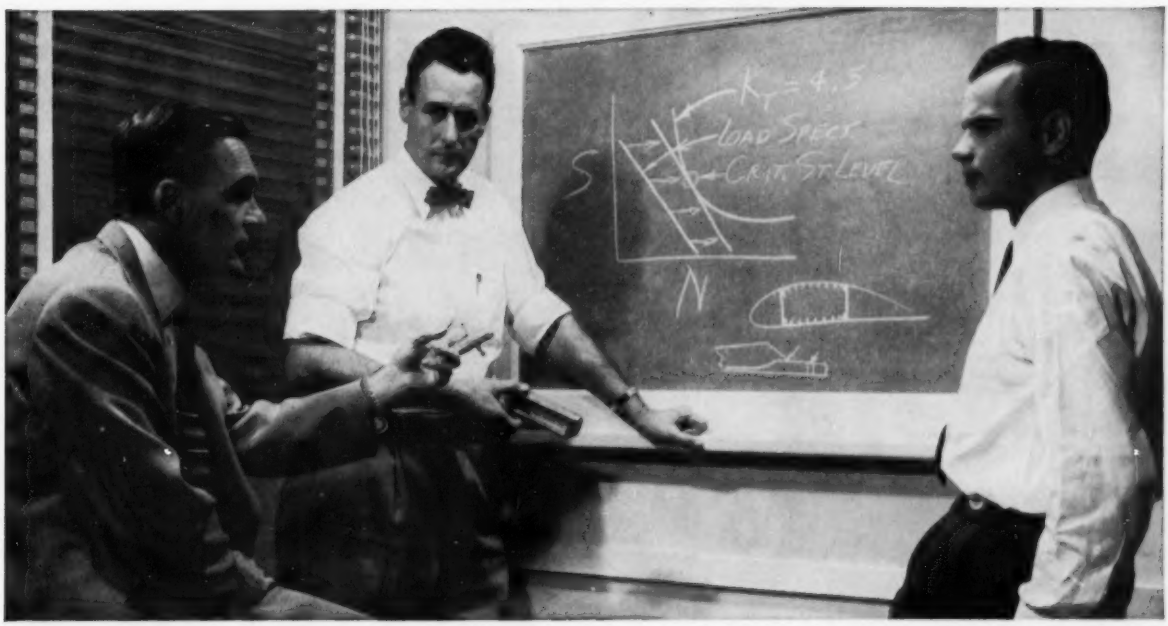
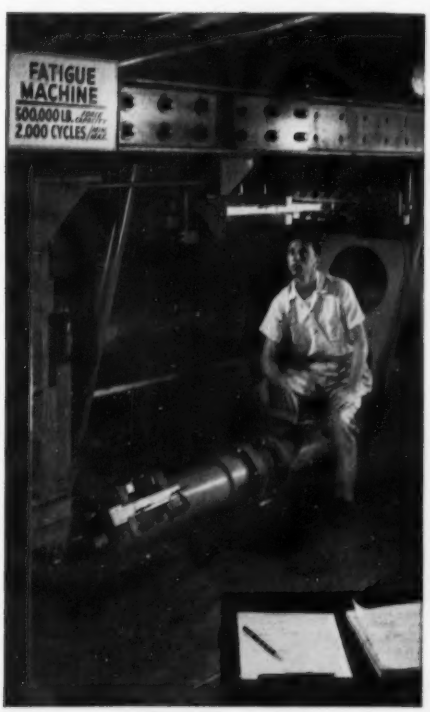


J. F. McBrearty, chief structures engineer (left) discusses fatigue test program of integrally-stiffened wing lower surface structure of a new transport with E. H. Spaulding, structures division engineer and J. G. Leewolt, stress engineer. Lockheed's 500,000 lb. Force Fatigue Machine was used in test program.

Advanced structures facilities speed careers of Lockheed Engineers



Ralph Oliva, research engineer, examines Super Constellation skin for signs of fatigue failure.

Engineers in Lockheed's Structures Division are supported by unmatched research and testing facilities in their constant effort to increase strength while decreasing weight.

Among those facilities are the Lockheed-designed 500,000 Lb. Force Fatigue Machine, first of its size; Shimmy Tower, only one in private industry; and Drop Test Tower, largest in the nation.

Facilities such as these give engineers a major advantage in making technical advances – and thus advancing their careers. Moreover, the large number of projects always in motion at Lockheed mean continuing opportunity for promotion as well as job security.

Why Lockheed needs Engineers with Structures training:

1. "Fail-Safe" Structures – Lockheed has begun an extensive pioneering effort in the new concept of "fail-safe" structures. Studies are being applied to virtually all phases of Lockheed's diversified development program – already the largest in the company's history.

2. New studies in: Effect of high temperatures on structures; optimization of thin-wing designs and other aero-elastic problems; new materials such as ultra-high heat treat steel; panel instability at extremely high speeds.

You are invited to contact your Placement Officer for a brochure describing life and work at Lockheed in the San Fernando Valley.

Lockheed
AIRCRAFT CORPORATION
BURBANK, **California**

STRESS and STRAIN...

Answers to this month's Brain Teasers:

1. The contractor bought 5 cars, 9 switches, and 28 track sections.
2. He should have the siding placed placed 75 miles from the town.

* * *

A young man addressed a letter to another young man pointing out that he understood the second fellow had been taking his engaged girl out. He requested that the offender call at his office and talk the matter over. Two days later he received this reply: "Received your circular letter. Will be at the meeting."

* * *

A young lady found herself for the week end with a notoriously strait-laced country family in England. Fearing that the pajamas she wore instead of a nightgown might be considered improper, she carefuly hid them every morning when she got up. But one morning at breakfast she suddenly realized that she had forgotten them, that they were lying brabenly on her bed. Excusing herself, she rushed to her room. The pajamas had disappeared.

While she was feverishly hunting for them, looking vainly through the closets and drawers, a dour, elderly maid appeared at the door and surveyed. "If it's the pajamas you're looking for Miss," she said, "I put them back in the young gentleman's room."

* * *

Familiarity breeds attempt.

If you have trouble remembering π to 30 *decimal* places then memorize this little rhyme. The number of letters in each word are the numbers in π.

3.14159265358979323846264338327 9

See, I have a rhyme assisting
My feeble brain its tasks sometimes resisting,
Efforts laborious can by its witchery
Grow easier, so hidden here are
The decimals all of circles periphery.

* * *

Maacop had wired a government bureau asking whether hydrochloric acid could be used to clean a certain type of boiler tube. The answer was:

"Uncertainties of reactive processes make the use of hydrochloric acid undesirable where alkilnity is involved."

The inquirer wrote back, thanking the bureau for the advice, saying that he would use the acid. The bureau wired him: Regrettable decision involves uncertainties. Hydrochloric acid will produce submuriate invalirdating reactions."

Again the man wrote back thanking them for their advice, saying that was glad to know that hydrochloric acid would be al right. This time the bureau wired in plain English: "Hydrochloric acid will eat hell out of your tube."

* * *

Courtship is that period which a girl decides if she can do better.

* * *

The devil sends the blessed winds
To raise the skirts on high;
But God is just—he sends the dust
To blind the wicked eye!

The big day was here. The wonderful gigantic bridge connecting two of the country's largest cities was being formally opened. At the height of the festivities, when thousands of people had thronged onto the bridge, the center span —with a crash heard for miles— fell into the bay, a mass of twisted girders and human bodies. The frenzied mayor seeing the engineer dashed up to him, "Look what you have done!"

The engineer, scratching his ear, replied, "I told Joe that decimal point was in the wrong place."

* * *

"I understand Jack studied mechanical engineering. What's he doing now?"

"He's working on the railroad."

"That so? What doing?"

"Well, you know the man who goes around the cars and taps all the wheels to make sure everything is all right?"

"Yes."

"Well, Jack helps that man listen."

* * *

An inebriate dreded the tongue-lashing from his wife that invariably accompanied his return home in the early morning hours. So, after a night of tippling, he returned home, went to the kitchen, tied skillets, pots and pans to the tied a rope about his waist, and rope in such a manner that they dragged behind him as he walked. Then he took off his shoes and stole softly upstairs.

"She'll never hear me in this infernal din," he whispered to himself as he crept toward the bedroom.

* * *

A good beginning and a good end make a good speech—if they come close enough together.

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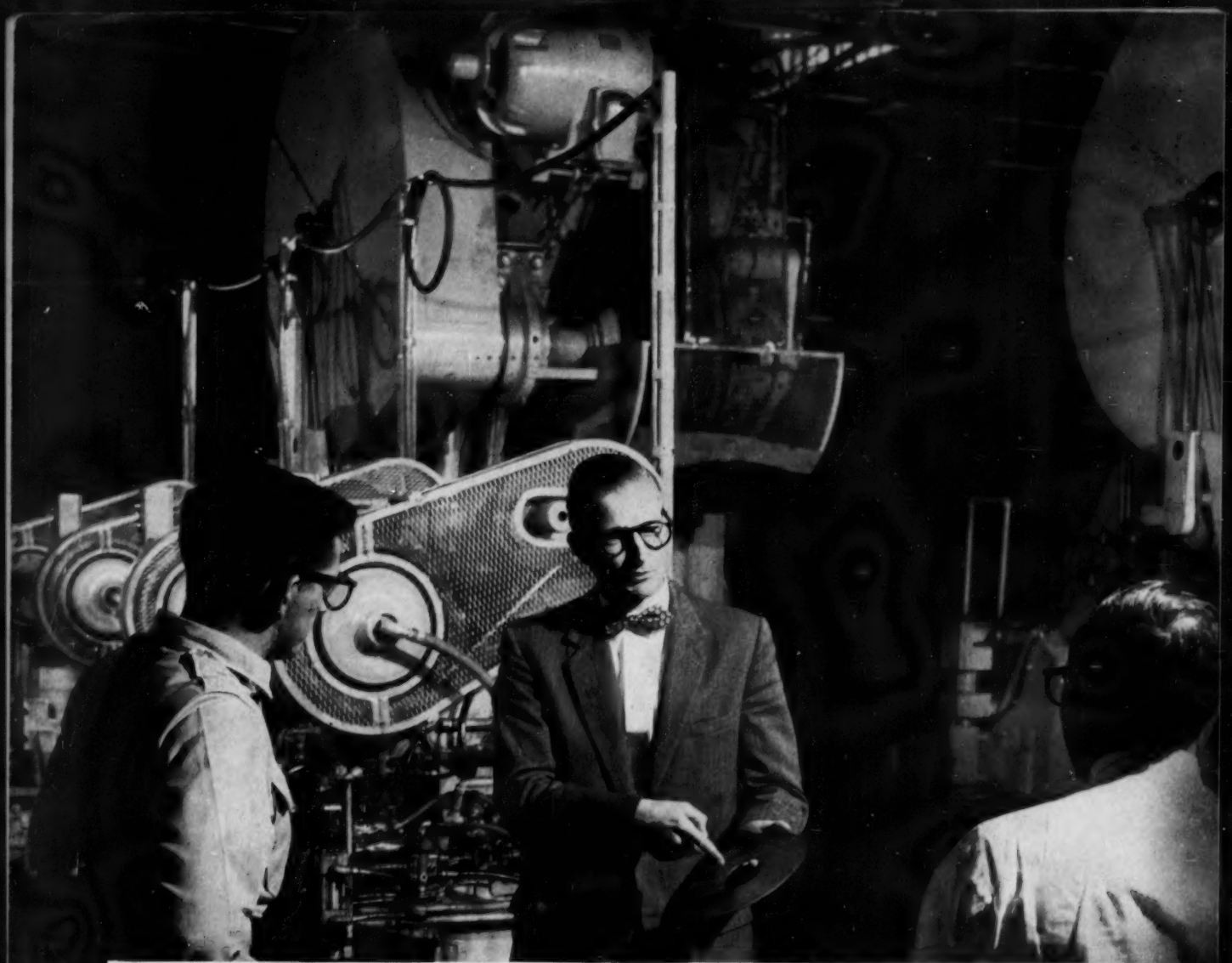

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